Sierra 340B

ENVELOPE DELAY TEST SET

OPERATION / MAINTENANCE MANUAL

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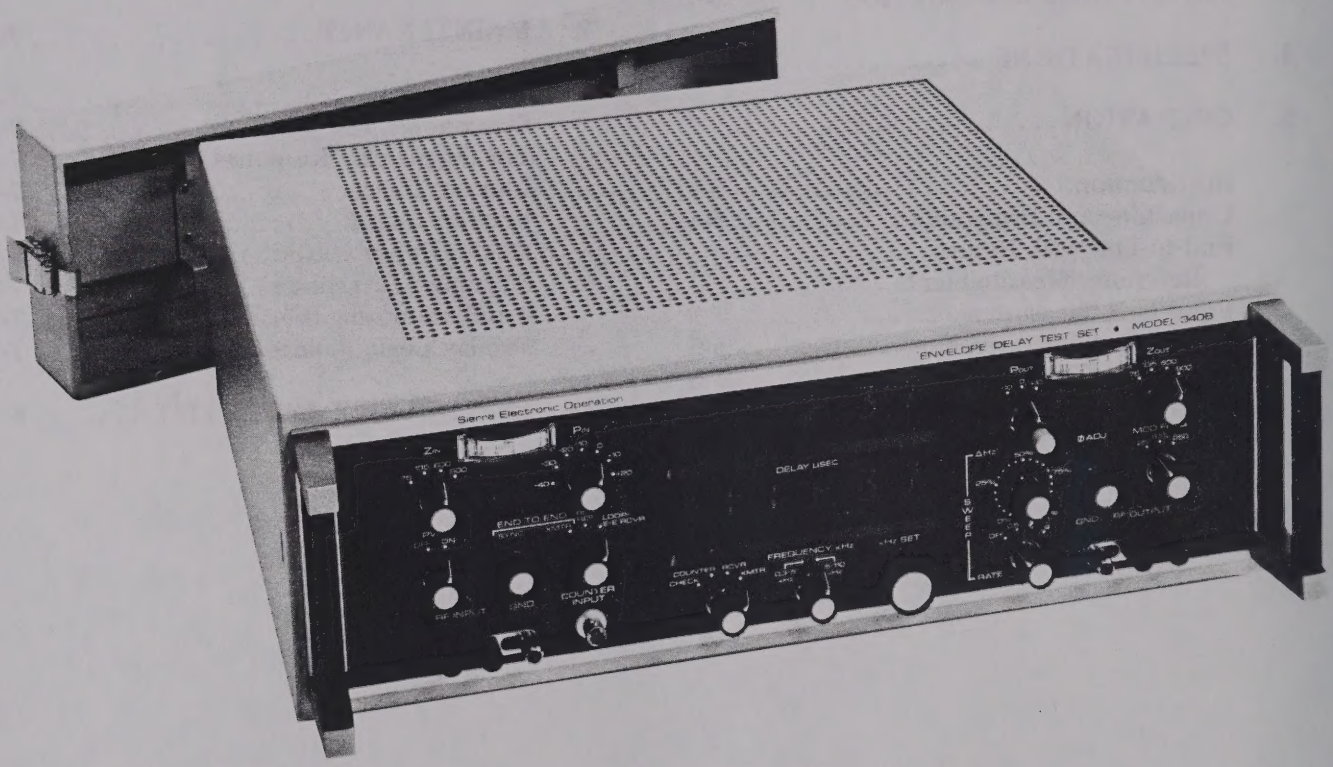


Figure 1. Sierra 340B Envelope Delay Test Set.

SECTION 1
GENERAL INFORMATION

1.01 This manual contains instructions on how to operate and perform maintenance on the Sierra 340B Envelope Delay Test Set. Maintenance instructions, Parts List, and schematic diagrams are contained in this manual. Maintenance, repair, or calibration facilities can obtain this manual by contacting Sierra Electronic Division. The Sierra 340B Envelope Delay Test Set Operation Manual, SOM-340B is also available to the operating facilities.

1.02 The Sierra 340B Envelope Delay Test Set measures envelope delay over the frequency range of 300 Hz to 110 kHz and in addition, measures the frequency of the transmitted or received signal. Both the delay and the frequency measurements are displayed on individual direct reading digital readouts. Measurement of delay is made in any of three modes: end-to-end with return reference, loop-back, or end-to-end. The 340B may also be used as a frequency counter over the range of 1 Hz to 1 MHz.

1.03 Features of the 340B are:

- Direct digital readout of delay in microseconds
- Single delay range for each modulation frequency
- Direct digital readout of frequency to nearest 10 Hz
- Covers 300 Hz to 110 kHz, for both voice and group frequencies of CCITT and Western Electric carrier multiplex systems
- Internal electronic sweep and 10-volt analog output of delay and frequency
- Precision internal master clock permits accurate end-to-end delay measurements without separate reference circuit
- Built-in 1 MHz frequency counter

SECTION 2
PHYSICAL DESCRIPTION

2.01 The 340B Envelope Delay Test Set is contained in a case measuring 19 inches in width, 5-¼ inches in height, and 14 inches in depth. It weighs 26 pounds when rack-mounted, or 43 pounds in a ruggedized case. Figure 1-1 illustrates the test set.

2.02 The major subassemblies contained within the set are: Sixteen circuit boards, four low-pass filters, a 1-megahertz oscillator, and the regulated power supplies. The two Nixie tube readouts and the operating controls and connectors are mounted on the front panel; with auxiliary controls, connectors, and the ac power input located on the rear panel. All active components with the exception of the Nixie tubes are solid-state, and most are integrated microcircuits.

2.03 The left section of the instrument contains the receiver components and controls; the logic, counting, and readout circuitry and controls are located in the center section; and the transmitter controls and circuitry are on the right.

2.04 The test set is powered by a self-contained power supply which draws approximately 70 watts of 95-to 125-volt (or 190- to 250-volt). 50- to 60-Hz commercial power. It will operate efficiently in an environment with an ambient temperature ranging from 15°C to 40°C.

2.05 Figures 2-1 and 2-2 show the front panel and rear panel, respectively, of the 340B. The controls, indicators, and connectors on the front panel are described in table 2-1, and those on the rear panel are described in table 2-2.

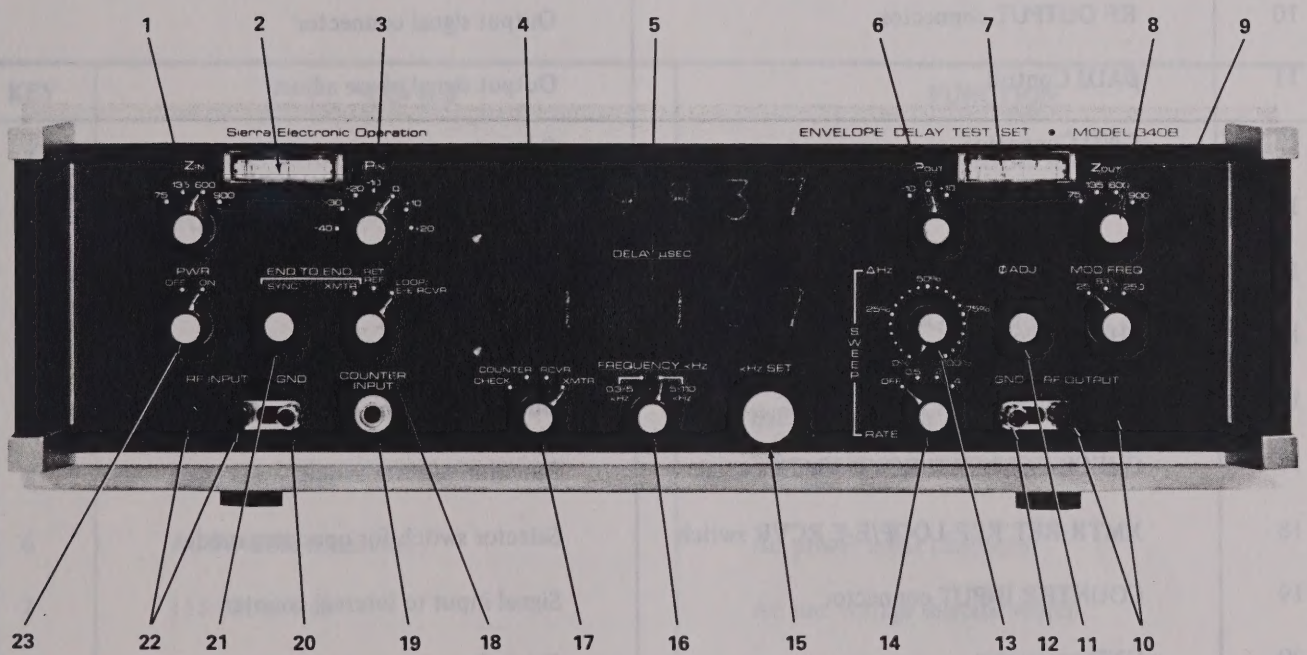


Figure 2-1. Sierra 340B Envelope Delay Test Set, Front Panel

Table 2-1. Front-Panel Controls, Indicators, and Connectors

KEY	DEVICE	FUNCTION
1	Z IN switch	Input inpedance selector switch.
2	Meter	Input signal dBm meter.
3	P IN switch	Input attenuator switch
4	FREQUENCY kHz display	Frequency Nixie tube readout
5	DELAY μSEC display	Phase delay Nixie tube readout
6	P OUT switch	Output level step attenuator switch
7	Meter	Output signal dBm meter
8	Z OUT switch	Output impedance selector switch
9	MOD FREQ, switch	Modulation frequency selector switch
10	RF OUTPUT connector	Output signal connector
11	ØADJ Control	Output signal phase adjust
12	GND Connector	Ground
13	SWEEP ΔHz control	Output signal sweep width adjust
14	SWEEP RATE switch	Output signal sweep rate selector and SWEEP off.
15	kHz SET control	Output signal frequency adjust
16	FREQUENCY kHz switch	Output frequency range switch
17	CHECK-COUNTER RCVR-XMTR switch	Function selector switch
18	XMTR-RET REF-LOOP/E-E RCVR switch	Selector switch for operating modes
19	COUNTER INPUT connector	Signal input to internal counter
20	GND connector	Ground
21	SYNC control	1-MHz varicap adjustment
22	RF INPUT connector	Input signal connector
23	PWR switch	Power on-off switch

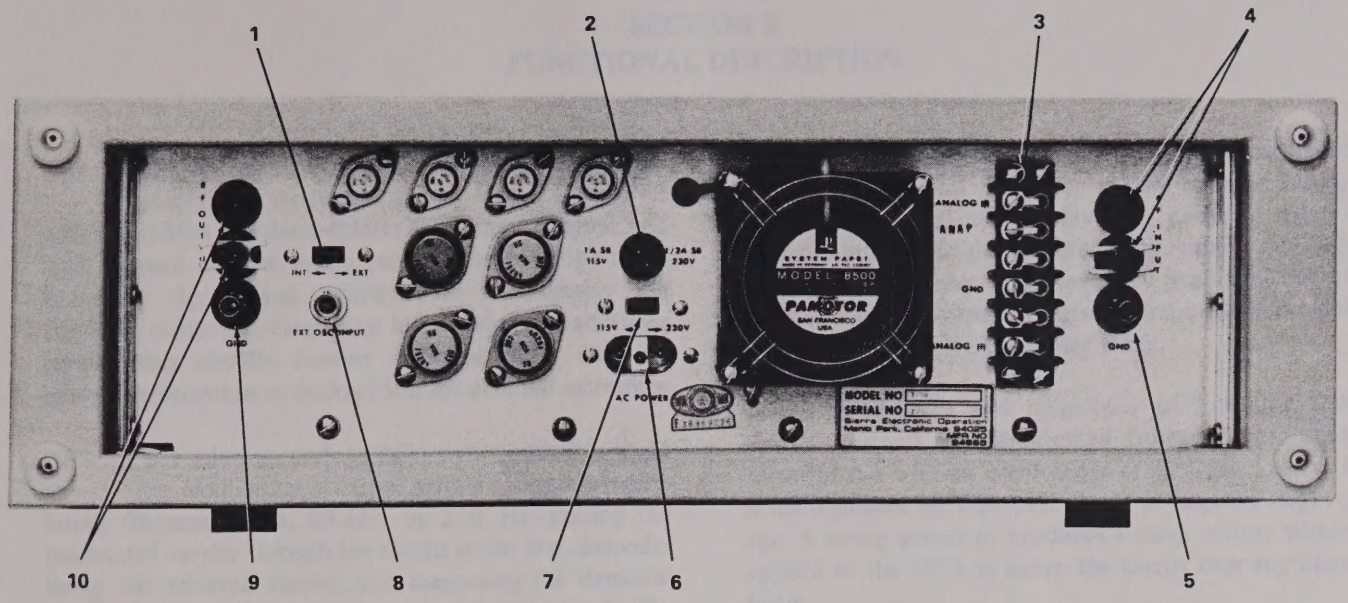
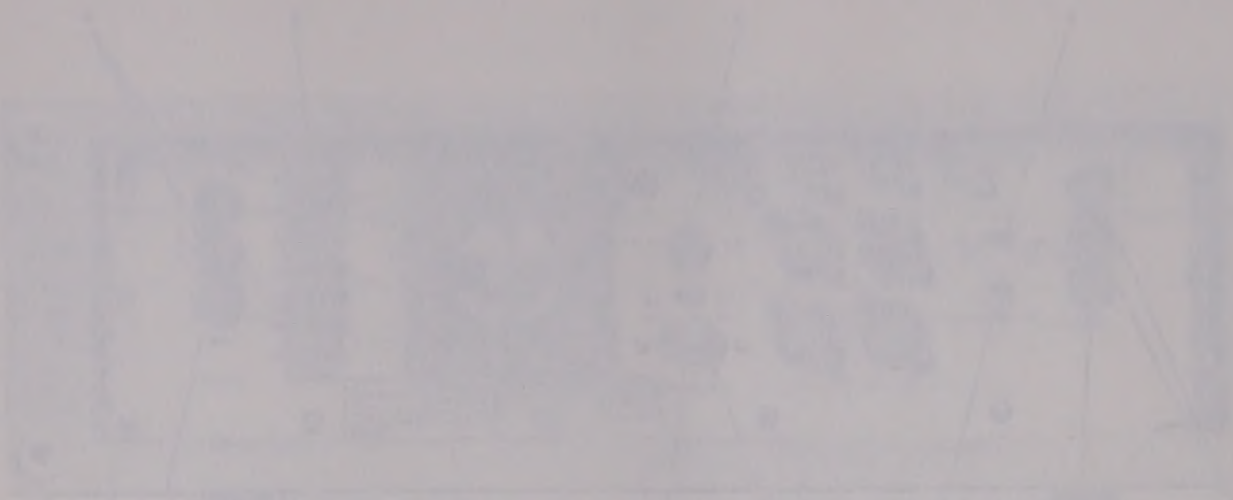


Figure 2-2. Sierra 340B Envelope Delay Test Set, Rear Panel

Table 2-2. Rear-Panel Controls, Indicators, and Connectors

KEY	DEVICE	FUNCTION
1	INT-EXT switch	Internal or external carrier selector switch
2	FUSE	Ac power fuse
3	Terminal Strip	Terminals for ANALOG (Ø) output, ANALOG output, ANALOG (f) output, and ground.
4	RF INPUT connector	Input signal connectors; parallels front-panel RF INPUT connector.
5	GND connector	Ground
6	AC POWER connector	Ac power input connector
7	115-230 switch	Ac line voltage selector switch
8	EXT OSC INPUT connector	External carrier input connector
9	GND connector	Ground
10	RF OUTPUT connector	Output signal connector; parallels front-panel RF OUTPUT connector.



SECTION 3
FUNCTIONAL DESCRIPTION

3.01 The 340B is composed of a transmitter which generates a modulated carrier signal, a Receiver which amplifies and demodulates the incoming signal, and logic control circuits which process the envelope delay frequency signals and which count and display the envelope delay and frequency information. In addition, conditioning circuits convert envelope delay and frequency information to analog form for external recording.

3.02 The relative envelope delay measurement is made by modulating a carrier with a reference modulating frequency –25, 83-1/3, or 250 Hz–passing the modulated carrier through the circuit under test, demodulating the received carrier, and comparing the demodulated signal with the reference modulating signal. The envelope time difference is then determined and displayed as the envelope delay, measured in microseconds. Refer to Block Diagram Figure 3-1.

3.03 The required carrier frequency is generated by a Voltage Controlled Oscillator (VCO) and the oscillator output carrier frequency is 50% modulated by a sine signal (25, 83-1/3, or 250 Hz) derived from the 1-MHz internal standard oscillator. The derived modulating signal is a square wave, but is passed through a low-pass filter to recover the fundamental frequency. The modulated carrier is then amplified and applied to the input of the line or equipment to be tested. The modulation phase is made adjustable so that convenient envelope delay reference points may be obtained.

3.04 The received signal is amplified and demodulated, and the output of the demodulator is applied to a zero crossing threshold detector. The output of the detector is a square wave which very accurately represents the zero crossings of the modulation envelope. This output is compared with the reference modulating frequency in the envelope delay and sign logic circuits to provide a signal proportional to envelope delay and indicate lead or lag. Zero crossings are compared twice per cycle to reduce errors due to signal variations and threshold detector shifts. Magnitude of envelope delay is converted to a dc level which is applied to an analog-to-digital converter to generate a frequency that is proportional to envelope delay. This frequency is then counted during a fixed time interval and displayed as envelope delay in microseconds. A single counter is sequentially shared for both envelope delay and frequency readings, but the count is stored in separate registers and presented on the respective banks of Nixie display tubes.

3.05 Frequency and magnitude of Envelope Delay outputs are conditioned from digital to analog form for use with an oscilloscope or recorder. Lead or lag is distinguished by a positive (lead) or negative (lag) voltage. A sweep generator produces a ramp voltage which is applied to the VCO to sweep the carrier over any desired band.

3.06 All the waveforms required for gate and pulse timing, modulation, and test are derived from the 1-MHz standard oscillator through decade and binary dividers. Frequencies of 1 MHz and 100 kHz are required for the check function, 50 Hz and 5 Hz are used as a clock in the control logic circuits and 1 kHz and 25 Hz are used for modulation and gating purposes. The 25-Hz output of the divider circuit is used directly, while the 1-kHz output is connected to the Modulation Frequency source boards where it is divided down to produce the required 83-1/3-Hz and 250-Hz outputs. These three outputs are switch selected for use in modulating the carrier and for gating in the phase and sign logic circuits.

3.07 The CHECK position tests all of the digital circuitry of the set. A reading of 40,000 microseconds ±1 count and 100.00 kHz ±1 count indicates proper operation of these circuits.

3.08 When the Test Set is switched to the COUNTER function, the COUNTER INPUT connector is used. The signal is conditioned in a separate pulse shaper circuit. At the same time the clock frequency to the control logic circuits is divided by 10, and the decimal point on the Nixie tube readout changed, so that the display may indicate frequency to ±1 Hz.

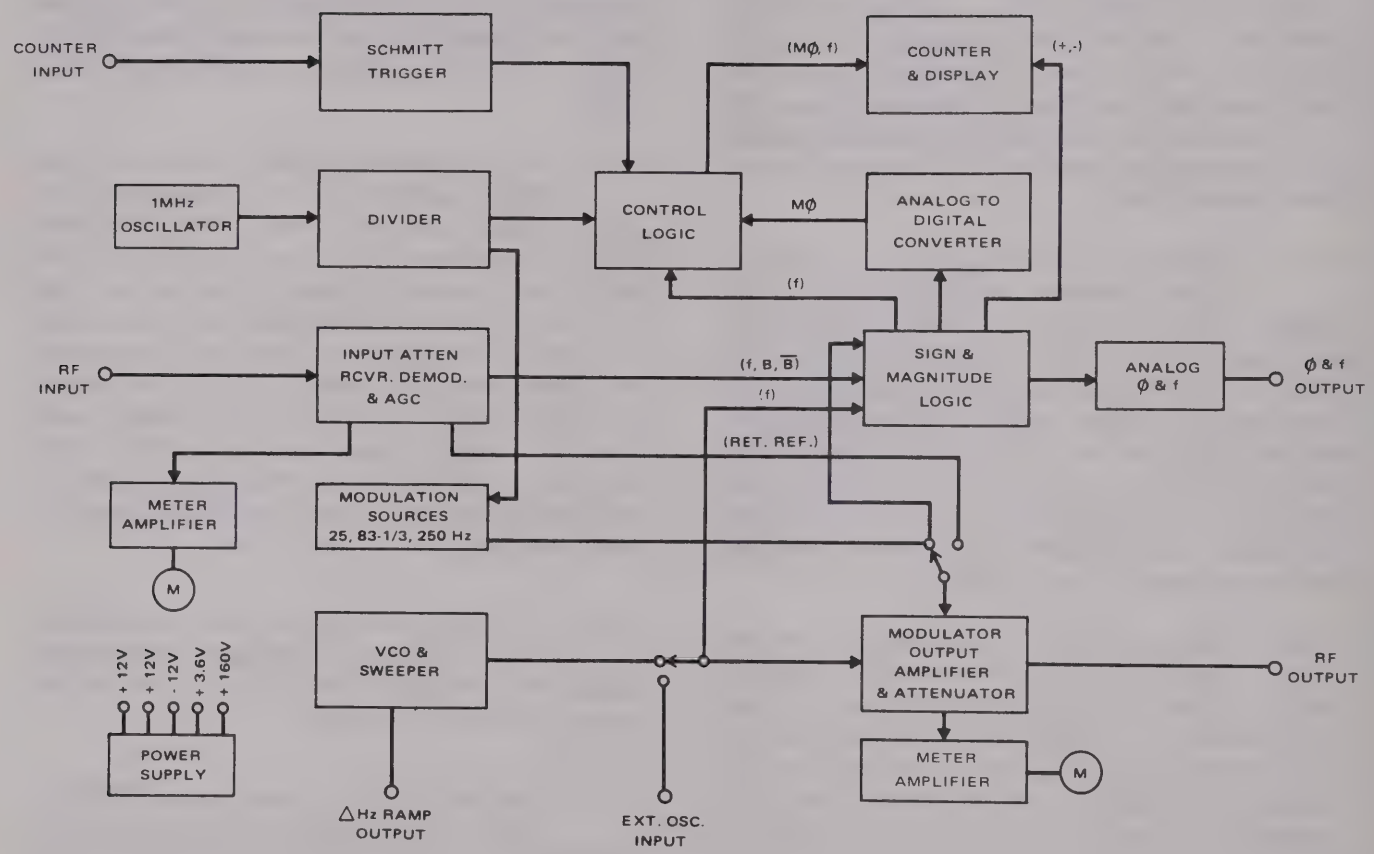


Figure 3-1. Sierra 340B Envelope Delay Test Set Block Diagram

SECTION 4
SPECIFICATIONS

4.01 Table 4-1 lists the specifications of the 340B.

Table 4-1. Specifications

PARAMETER	CHARACTERISTIC
Carrier	
Frequency (Note 1)	300 Hz to 110,000 Hz
Readout Type	Digital
Readout Accuracy (Note 2)	±1 digit; ±10 Hz
Power Output Flatness	0.3 to 5 kHz; ±0.15 dB 5 to 60 kHz; ±0.5 dB 5 to 110 kHz; ±0.75 dB
Modulation Frequency	25 Hz, 83-1/3 Hz (0.3-110 kHz) 250 Hz (2.5-110 kHz)
Modulation Percentage	50% (fixed)
Delay Measurements	
Readout Type	Digital
Time Period (Note 3)	±200 to ±18,500 μsec (25-Hz modulation) ±100 to ±5500 μsec (83-1/3 Hz modulation) ±20 to ±1850 μsec (250-Hz modulation)
Accuracy (Note 2)	
Transmitter	±0.3% at 20° to 24° C, with receiver input power constant to within 0.5 dB. ±2%, ±5 μsec over rated temperature range and with 0 to −10 dB indicated input power.
Output Power	−20 dBm to 0 dBm, 75 and 135 ohms (usable to +10 dBm; continuously adjustable) −20 dBm to −10 dBm, 600 ohms, 900 ohms (usable to 0 dBm; continuously adjustable)
Readout Type	Meter
Readout Accuracy (Note 2)	±0.5 dB (0.3-60 kHz) ±1.0 dB (60-110 kHz) **NOTE:** The transmitter readout accuracy is due to the transmitter meter circuitry response. The power output flatness remains as specified.

Table 4-1. Specifications (Cont)

PARAMETER	CHARACTERISTIC
Output Impedance (Note 4)	75 ohms unbalanced; 135, 600, and 900 ohms balanced or unbalanced; ±5% over above frequency range.
Sweep Mode	0.5, 2, or 4 sweeps per minute. Continuously adjustable over the entire carrier frequency range.
Receiver	
Input Power	–50 dBm to +20 dBm.
Readout Type	Meter
Readout Accuracy	±0.5 dB (0.3-60 kHz) ±1.0 dB (60-110 kHz)
Input Impedance (Note 4)	75 ohms unbalanced; 135, 600, and 900 ohms balanced or unbalanced: ±5% over above frequency range.
Operating Modes	End-to-end with return reference; loop-back; and end-to-end.
Counter Mode	
Frequency Accuracy (Notes 2 and 5)	±1 digit; ±1 Hz (1 Hz to 1 MHz)
Input Level	–10 dBm to +10 dBm (600 ohms)
Input Impedance	10K ohms shunted with 25 pF.
Meter and Oscilloscope Output (Rear Panel)	
Delay	+10V, ±20,000 μsec, 25-Hz modulation +10V, ±6,000 μsec, 83-1/3-Hz modulation +10V, ±2,000 μsec, 250-Hz modulation
Frequency	+10 V/5 kHz 0 to 5 kHz +10 V/110 kHz 0 to 110 kHz
Analog Power	Approximately +1 to +10 Vdc. Correspond to –20 dBm to 0 dBm
Component Complement	Completely solid-state except for Nixie tubes
Electrical Requirements	
Voltage	110 ±15V or 220 ±30V, 50-60 Hz
Power (Steady State)	70 watts

Table 4-1. Specifications (Cont)

PARAMETER	CHARACTERISTIC
Environmental Characteristics	
Temperature	(59° F to 104° F) (15° C to 40° C)
Vibration and Shock	As encountered with commercial carrier and laboratory usage
Mechanical Characteristics	
Height	5-1/4 inches
Width	19 inches
Depth	14 inches
Weight	26 pounds (for rack mounting) 43 pounds (for ruggedized case)

NOTES:

1. Connector available (rear panel) to accept an external carrier.
2. Accuracy and stability limits are applicable only after a thirty-minute warmup period from cold turn-on. If instrument has been plugged into main power for at least thirty minutes, then accuracy and stability limits are applicable after a five-minute warm-up (except for end-to-end measurements which require the 1-MHz oscillator to be on for 1 hour minimum).
3. The instrument should not be used within ±200 microseconds of 00000.
4. DC input and/or output voltage must be zero volts ±0.1 volt when operating at 75-ohm impedance.
5. Counter accuracy is adjustable over a range of 8 ppm by front-panel **SYNC** control.
6. The following maximum limits are applicable to units which do not contain the 1-MHz varicap adjustments:

   ±1 digit, ±15 μsec (25-Hz modulation)
   ±1 digit, ±20 μsec (83-1/3-Hz modulation)
   ±1 digit, ±30 μsec (250-Hz modulation)

7. Dc input and/or output voltage must be 0 volts. If a dc voltage exists on the line or equipment to be tested use an isolation transformer adapter for the receiver (RF INPUT) or transmitter (RF OUTPUT). An input/output Coupling Transformer, for balanced lines and dc isolation, is available as an accessory.

SECTION 5
OPERATION

Introduction

5.01 This section of the manual describes the method of making end-to-end with return reference measurements, loop-back measurements, and end-to-end measurements. It also explains the use of the analog output, the use of the frequency counter, and the use of external carrier in place of the internally generated carrier.

Unpacking and Inspection

5.02 Carefully unpack and inspect the instrument for damage. If any evidence of damage is observed, contact:

ADDRESS: Customer Service Department
Lear Siegler, Inc.
Sierra Electronic Division
3885 Bohannon Drive
Menlo Park, California 94025
Telephone (415) 321-5374
TWX 910-373-1282

NOTE: Do not repackage damaged or faulty equipment for return to Sierra Electronic Division under the provisions of the Warranty without first contacting Sierra for specific instructions.

End-to-End With Return Reference Measurements

5.03 **TEST SET CALIBRATION**: The 340B should be calibrated as follows prior to performing end-to-end measurements.

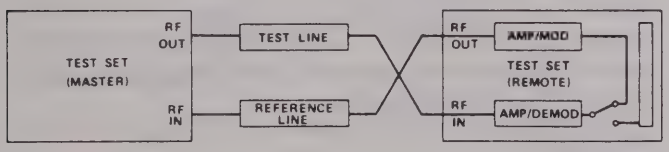


Figure 5-1. End-to-End Measurement with Return Reference

Step 1
Check rear panel to make sure that the 115V-230V ac line voltage selector switch is in the correct position. Plug into the ac power source.

Step 2
Turn PWR switch to ON. Allow the instrument to warm up for at least 30 minutes.

NOTE: Accuracy and stability limits are applicable only after a 30-minute warmup period from cold turn-on. If instrument has been plugged into main power for at least 30 minutes, then accuracy and stability limits are applicable after a 5-minute warmup (except for end-to-end measurements which require 1-MHz oscillator to be on for 1 hour minimum).

Step 3
Set CHECK-COUNTER-RCVR-XMTR switch to CHECK. (If the instrument is not connected into a circuit and so has no signal input, place the SYNC-XMTR-RET REF-LOOP/E-E RCVR Switch in the XMTR Position. Set P IN attenuator switch for a 0 to −10 dBm indication on the input power meter.

Step 4
DELAY readout should indicate 40,000 μsec ±1 digit. (Upper Nixie tube readout).

Step 5
FREQUENCY kHz should read 0100.00 ±1 digit. (Lower Nixie tube readout).

NOTE: When the function switch is in the RCVR or XMTR position the input or output frequency may be read on the frequency display the nearest hundredth kHz. A phase delay display of −10,000 μsec ±1000 to +4,000 μsec ±1000 is possible by adjusting ∅ ADJ control from stop to stop when MOD FREQ switch is in the 25 Hz position. (This is an operational check on the A-D converter.) When the function switch is put in the COUNTER position, the frequency decimal points moves one place to the left. The COUNTER INPUT connector (J2) must be used.

5.04 **PANEL CONTROL SETTINGS, MASTER TEST SET**: The master test set controls are set in the following manner.

Step 1
Set INT-EXT Switch on the rear panel to the INT Position.

Step 2
Set Z OUT to the impedance of the input of the test line, and Z IN to the impedance of the output of the reference line.

CAUTION: Before switching from a higher to a lower output impedance (Z OUT switch) always reduce power output to a low level with the P OUT switch. This will prevent overloading and possible damage to the output amplifier.

Step 3
Adjust P OUT for the normal power input level of the circuit under test. (P OUT is a dual control. The switch is for coarse adjustment, 10 dB steps, and the center control, a potentiometer, is for the fine adjustment.)

NOTE: Power output is the algebraic sum of the P OUT switch setting and the Output DBM meter reading. The P IN meter on the receiver is read in the same manner.

Step 4
Set the P IN attenuator switch so that a reading between –10 dBm and 0 dBm is obtained on the Input Signal DBM Meter scale.

NOTE: The minimum usable input signal level is –45 dBm.

Step 5
Set SWEEP RATE Switch to OFF, MOD FREQ to the proper modulation frequency, CHECK-COUNTER-RCVR-XMTR switch to XMTR and XMTR-RET. REF-LOOP/E-E RCVR Switch to LOOP/E-E RCVR.

NOTE: Standard modulation frequencies of the switch positions are: 25 Hz, 83-1/3 Hz, 250 Hz. Observe that in the 250 Hz position, the decimal point in the DELAY readout shifts one position to the left, making the maximum reading ±2000.0 microseconds.

5.05 PANEL CONTROL SETTINGS, REMOTE TEST SET: The remote test set controls are set in the following manner:

Step 1
Set INT-EXT Switch on the rear panel to the INT position.

Step 2
Set Z OUT to the impedance of the input of the reference line, and Z IN to the impedance of the output of the test line. See Caution above regarding changing the setting of the Z OUT switch.

Step 3
Adjust P OUT for the normal power input level of the reference return line.

Step 4
Set the P IN attenuator switch so that a reading between –10 dBm and 0 dBm is obtained on the Input Signal DBM Meter scale.

Step 5
Set SWEEP RATE Switch to OFF, MOD FREQ to 83-1/3, CHECK-COUNTER-RCVR-XMTR switch to XMTR and XMTR-RET REF-LOOP/E-E RCVR switch to RET REF. Position.

5.06 CONNECTION TO CIRCUIT EQUIPMENT: Under this test the following steps should be accomplished when connecting the 340B to a circuit or other equipment.

CAUTION: **Units with s/n below 350**
When Z IN or Z OUT switches are in the 75 position, check the circuit to be tested for the presence of any dc voltage of ±0.1 volts or more before making the connection. If a voltage of this level exists, connect the Test Set, Input or Output, through an external coupling transformer.

Step 1
Connect the RF OUTPUT of the Master Test Set to the Master Test Set to the line to be tested, and connect the RF INPUT to the reference line.

Step 2
Connect the RF OUTPUT of the Remote Test Set to the reference line, and connect the RF INPUT to the line to be tested.

NOTE: If the input or output is unbalanced, the ground strap must be left connected between the center and the GND binding post. If the input or output is balanced, remove the strap from Front and Rear.
(See CAUTION above for s/n below 350).

5.07 ENVELOPE DELAY MEASUREMENT: Envelope delay measurements are made in the following manner:

Step 1
Adjust the kHz SET control of the Master Test Set to a desired in-band reference frequency.

Step 2
Rotate the ∅ ADJ control of the Master Test Set to obtain a reference envelope delay reading (such as +1000 μsec).

NOTE: At this point it may be necessary to vary the Remote Test Set ∅ ADJ control to obtain a positive envelope delay reference reading on Master Test Set.

A reference envelope delay reading of 0000 ±200 μsec should not be used. In addition, the reference point should be offset sufficiently to preclude readings crossing the zero point.

Step 3
At the Remote Test Set, adjust the kHz SET control to a desired in-band return reference frequency (such as 1.0 kHz for the audio band). Nothing further should be done at the Remote Test Set.

Step 4
Adjust the Master Test Set to the frequency points of interest and record the envelope delay readings. For example: With the Master Test Set reference frequency set to: f ref = 1.00 kHz and envelope reference delay set to ∅ ref = +1000 μsec.

NOTE: For oscilloscope display, X-Y recorder, and strip chart recorder use see paragraphs 5.18, 5.19, and 5.20.

Tabulate readings:

Frequency (kHz)	Delay Reading (μsec)	∅ ref (μsec)	Envelope Delay (μsec)
000.60	+1073	+1000	+73
001.40	+ 950	+1000	- 50

NOTE: Since the return reference line envelope delay remains constant, because the carrier frequency is not changed, the relative envelope delay for the line under test may be determined for any carrier frequency transmitted by the Master Test Set. Envelope Delay is always the algebraic difference between the Delay reading and the Reference Delay.

Step 5
Reversing the function of the Master and Remote Test Sets allows the envelope delay of the return reference line to be measured and thereby provides end-to-end, or one-way, envelope delay information for both lines.

NOTE: At carrier frequencies which are harmonically related to the modulation frequency, fluctuations of envelope delay reading may occur. The lower the carrier frequency, the larger the fluctuations will be. This condition has a very restricted bandwidth, so that a very slight adjustment of the carrier frequency (1-3 Hz) will eliminate the condition. At carrier frequencies above 600 Hz the bandwidth at which this may occur is less than ±1 Hz.

Loop-Back Measurements

5.08 TEST SET CALIBRATION: The 340B should be calibrated as follows prior to performing loop-back measurements.

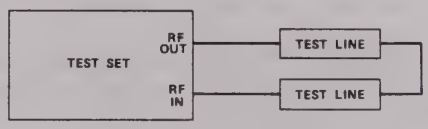


Figure 5-2. Loop-Back Measurement

Step 1
Check the rear panel to make sure that the 115V-230V ac line voltage selector switch is in the correct position. Plug into the ac power source.

Step 2
Turn PWR switch to ON. Allow the instrument to warm up for at least 30 minutes.

NOTE: Accuracy and stability limits are applicable only after a 30-minute warmup period from cold turn-on. If instrument has been plugged into main power for at least 30 minutes, then accuracy and stability limits are applicable after a 5-minute warmup (except for end-to-end measurements which require 1-MHz oscillator to be on for 1 hour minimum).

Step 3
Set CHECK-COUNTER-RCVR-XMTR switch to CHECK. (If the instrument is not connected into a circuit and so has no signal input, set the XMTR-REF-LOOP/E-E RCVR Switch to the XMTR Position. Set P IN attenuator Switch for a -10 to 0 dBm indication on the input power meter.

Step 4
DELAY readout should indicate 40,000 μsec ±1 digit. (Upper Nixie tube readout).

Step 5
FREQUENCY kHz should read 0100.00 ±1 digit. (Lower Nixie tube readout).

NOTE: When the function switch is in the RCVR or XMTR position the input or output frequency may be read on the frequency display the nearest hundredth kHz. A phase delay display of -10,000 μsec ±1000 to +4,000 μsec ±1000 is possible by adjusting 0 ADJ control from stop-to-stop when MOD FREQ switch is in the 25 Hz position. (This is an operational check on the A-D converter.) When the function switch is put in the COUNTER position, the frequency decimal point moves one place to the left. The COUNTER INPUT connector (J2) must be used.

5.09 PANEL CONTROL SETTINGS: For loop-back measurements the front panel controls should be set to the following positions:

Step 1
Set INT-EXT Switch on the rear panel to the INT Position.

Step 2
Set Z OUT to the impedance of the Input, and Z IN to the impedance of the Output of the circuit to be tested.

CAUTION: Before switching from a higher to a lower output impedance (Z OUT switch) always reduce power output to a low level with the P OUT switch. This will prevent overloading and possible damage to the output amplifier.

Step 3
Set SWEEP RATE Switch to OFF, MOD FREQ to the proper modulation frequency, CHECK COUNTER-RCVR-XMTR switch to XMTR and XMTR-RET-LOOP/E-E RCVR Switch to LOOP/E-E RCVR.

NOTE: Standard modulation frequencies of the switch positions are 25 Hz, 83-1/3 Hz, 250 Hz. Observe that in the 250 Hz position the decimal point in the DELAY readout shifts one position to the left, making the maximum reading ±2000.0 microseconds.

Step 4
Adjust P OUT for the normal power input level of the circuit under test. (P OUT is a dual control. The switch is for coarse adjustment, 10 dB steps, and the center control, a potentiometer, is for fine adjustment.)

NOTE: Power output is the algebraic sum of the P OUT switch setting and the Output DBM Meter reading. The P IN meter on the receiver is read in the same manner.

Step 5
Set the P IN attenuator switch so that a reading between -10 dBm and 0 dBm is obtained on the Input Signal DBM Meter scale.

NOTE: The minimum usable input signal level is -45 dBm.

5.10 CONNECTION TO CIRCUIT OR EQUIPMENT: Under this test the following should be accomplished when connecting the 340B to a circuit or other equipment.

CAUTION: When Z IN or Z OUT switches are in the 75 position, check the circuit to be tested for the presence of any dc voltage of ±0.1 volts or more before making the connection. If a voltage of this level exists, connect the Test Set, Input or Output, through an external coupling transformer.

Step 1
Connect the input of the circuit under test to RF OUTPUT on the Test set.

NOTE: If the input is unbalanced, the ground strap must be left connected between the center and the GND binding post. If the input or output is balanced, remove the strap from front and rear panels. (See CAUTION, above.)

5.11 ENVELOPE DELAY MEASUREMENT: Envelope delay measurements are performed in the following manner:

NOTE: For oscilloscope display, X-Y recorder, and strip chart recorder use see paragraphs 5.18, 5.19, and 5.20.

Step 1
Adjust kHz SET control to the desired in-band reference (such as 1.00 kHz, for audio range, as read on the lower readout).

Step 2
Rotate the ∅ ADJ control to obtain a reference envelope delay reading at the reference frequency, such as +1000 μsec.

NOTE: A reference envelope delay reading of 0000 ±200 μsec should not be used. In addition the reference point should be offset sufficiently to preclude readings crossing the zero point. The instrument is now ready for use.

Step 3
Adjust the frequency to the points of interest and record the envelope delay readings for example: with reference frequency set to: f ref = 1.00 kHz and envelope reference delay set to: ∅ref = +1000 μsec.

Tabulate readings:

Frequency (kHz)	Delay Reading (μsec)	∅ ref (μsec)	Envelope Delay (μsec)
000.60	+1073	+1000	+73
001.40	+ 950	+1000	- 50

NOTE: Envelope Delay is always the algebraic difference between the Delay reading and the Reference Delay.

NOTE: At carrier frequencies which are harmonically related to the modulation frequency fluctuations of envelope delay readings may occur. The lower the carrier frequency, the larger the fluctuations will be. This condition has a very restricted bandwidth, so that a very slight adjustment of the carrier frequency (1-3 Hz) will eliminate the problem. At carrier frequencies above 600 Hz the bandwidth at which this occurs is less than ±1 Hz.

End-to-End Measurements

5.12 Circuit envelope delay measurements may be made on an end-to-end basis when a Sierra 340B Envelope Delay Test Set is available at each terminal. Operator procedure at each end may be synchronized over an order wire or on a time schedule basis. Another set having a modulation frequency of 25 Hz, 83-1/3 Hz or 250 Hz may be used. The accuracy of the reading will then be determined by the set having the poorest stability and setability, with setability usually being the determining factor.

5.13 **TEST SET CALIBRATION, TRANSMIT AND RECEIVE SETS**: The transmit and receive test sets should be calibrated in the following manner:

Step 1
Check the rear panel to make sure that the 115V-230V ac line voltage selector switch is in the correct position. Plug into the ac power source.

Step 2
Turn PWR switch to ON. Allow the instrument to warm up for at least 30 minutes (1 MHz oscillator warmup 1 hour minimum).

NOTE: Accuracy and stability limits are applicable only after a 30-minute warmup period from cold turn-on. If instrument has been plugged into main power for at least 30 minutes, then accuracy and stability limits are applicable after a 5-minute warmup (except for end-to-end measurements which require 1-MHz oscillator to be on for 1 hour minimum).

Step 3
Set CHECK-COUNTER-RCVR-XMTR switch to CHECK. (If the instrument is not connected into a circuit and has no signal input, place the XMTR-RET-REF LOOP/E-E RCVR Switch in the XMTR Position. Set P IN Switch for a 0 to –10 dBm indication on the input power meter.

Step 4
DELAY readout should indicate 40000 μsec ±1 digit. (Upper Nixie tube readout).

Step 5
FREQUENCY kHz should read 0100.00 ±1 digit (Lower Nixie tube readout).

NOTE: When the function switch is in the RCVR or XMTR position the input or

output frequency may be read on the frequency display the nearest hundredth kHz. A phase delay display of −10,000 μsec ±1000 to +4,000 μsec ±1000 is possible by adjusting ∅ ADJ control from stop-to-stop when MOD FREQ switch is in the 25 Hz position. (This is an operational check on the A-D converter.) When the function switch is put in the COUNTER position, the frequency decimal point moves one place to the left. The COUNTER INPUT connector (J2) must be used.

5.14 **PANEL CONTROL SETTINGS, TRANSMIT TEST SET:** The following steps place the controls for the transmit test set in the proper positions.

Step 1
Set INT-EXT Switch on the back panel to the INT Position.

Step 2
Set Z OUT to the impedance of the circuit to be tested.

CAUTION: Before switching from a higher to a lower output impedance (Z OUT switch) always reduce power output to a low level with the P OUT switch. This will prevent overloading and possible damage to the output amplifier.

Step 3
Adjust P OUT for the normal input level of the circuit under test. (P OUT is a dual control. The switch is for coarse adjustment, 10 dB steps, and the center control, a potentiometer, is for fine adjustment.)

NOTE: Power output is the algebraic sum of the P OUT switch setting and the Output DBM Meter reading.

Step 4
Set SWEEP RATE Switch to the OFF Position, MOD FREQ to the proper modulation frequency, CHECK-COUNTER-RCVR-XMTR switch to XMTR and XMTR-RET REF-LOOP/E-E RCVR switch to the XMTR Position.

NOTE: Standard modulation frequencies of the switch positions are: 25 Hz; 83-1/3 Hz; 250 Hz. Observe that in the 250 Hz position, the decimal point in the DELAY readout shift one position to the left, making the maximum reading +2000.0 microseconds.

Step 5
Set the P IN attenuator for a meter reading between −10 dBm and 0 dBm.

Step 6
Rotate the ∅ ADJ approximately mid-range.

5.15 **PANEL CONTROL SETTINGS, RECEIVER TEST SET:** The following steps place the controls for the receive test set in the proper position.

Step 1
Set INT-EXT Switch on the back panel to the INT position.

Step 2
Set Z IN to the impedance of the circuit to be tested.

Step 3
Set P IN switch to +20 dBm.

NOTE: Power input is the algebraic sum of the P IN switch setting and the Input DBM Meter reading. The Minimum usable input signal level is −45 dBm.

Step 4
Set the SWEEP RATE Switch to the OFF Position, MOD FREQ Switch to the proper modulation frequency, CHECK-COUNTER-RCVR-XMTR switch to the RCVR and the XMTR-RET REF-LOOP/E-E RCVR Switch to LOOP E/E RCVR Position.

5.16 **CONNECTION TO CIRCUIT OR EQUIPMENT:** The following steps should be followed when connecting the transmit and receive test sets to a circuit or a piece of equipment.

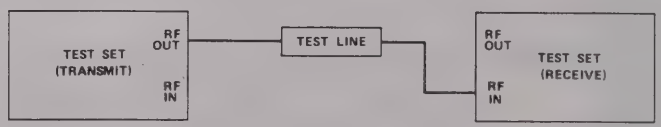


Figure 5-3. End-to-End Measurement

Step 1
On the Transmit Test Set, connect the RF OUTPUT to the input of the circuit to be tested. Recheck power output.

Step 2
On the Receive Test Set, connect the RF INPUT to the output of the circuit to be tested. Set P IN for a meter scale reading between −10 dBm and 0 dBm.

NOTE: If the input or output is unbalanced, the ground strap must be left connected between the center and the GRD binding post. If the input or output is balanced, remove the strap from front and rear.

CAUTION: When Z IN or Z OUT switches are in the 75 position, check the circuit to be tested for the presence of any dc voltage of ±0.1 volts or more before making the connection. If a voltage of this level exists, connect the Test Set, Input or Output, through an external coupling transformer.

5.17 **ENVELOPE DELAY MEASUREMENT:** Envelope delay measurements are performed in the following manner:

Step 1
At the Transmit Test Set adjust the kHz SET control to a desired in-band reference frequency, such as 1.00 kHz.

NOTE: A reference envelope delay reading of 0000 ±200 μsec should not be used. In addition, the reference point should be offset sufficiently to preclude readings across the zero point.

Step 2
At the Receiver Set, adjust SYNC Control for an envelope delay stability of ± count ±5 microseconds, maximum, in ten minutes. Rotate the SYNC Control a few degrees and note the rate of the roll of the delay reading. If the rate of roll decreases, rotate the SYNC Control a few more degrees in the same direction. If the rate of roll increases, rotate the SYNC Control in the opposite direction a few degrees. Continue this process until the envelope delay stability is within the described limits.

Step 3
At the Transmit Set, adjust 0 ADJ Control for a positive envelope delay reference indication at the receiver. Any positive envelope delay reference may be used as long as the reference plus the envelope delay to be measured does not exceed 6000 sec with 83-1/3 Hz modulation. (18,000 sec with 25 Hz modulation and 2,000 sec with 250 Hz modulation). If this reference is not possible, either:

1. Momentarily deenergize the Receiver Set, then readjust ∅ ADJ control on the Transmit set to get a positive envelope reference.

2. Unsynchronize the Receiver Set, allow the phase to drift into range, then repeat steps 2 and 3.

NOTE: The instruments are now ready for use.

Step 4
Instruct the transmit operator to set the Transmit Test to the required frequencies. At the Receive Test Set read and record the envelope delay readings for each frequency. For example: with reference frequency set to: f ref = 1.00 kHz and envelope reference delay set to: ∅ ref = +1000 μsec.

Tabulate readings:

Frequency (kHz)	Delay Reading (μsec)	∅ref (μsec)	Envelope Delay (μsec)
000.60	+1073	+1000	+73
001.40	+ 950	+1000	- 50

NOTE: Envelope Delay is always the algebraic difference between the Delay Reading and the Reference Delay.

Use of Analog Output

5.18 **FOR OSCILLOSCOPE DISPLAY:** When using the 340B with an oscilloscope perform the following steps:

Step 1
Connect oscilloscope vertical input (dc) to ANALOG (∅) on rear terminal block, TB5, of Test Set (Figure 2-2). The envelope Delay output will be:

+10 volts ±20,000 μsec for 25 Hz modulation
+10 volts ±6,000 μsec for 83-1/3 Hz modulation
+10 volts ±2,000 μsec for 250 Hz modulation

Step 2
Connect oscilloscope horizontal input (dc) to analog (f). Set FREQUENCY kHz Switch to the 5-110 kHz position. Approximate output will be +10.0 volts per 110 kHz bandwidth.

Step 3
Set FREQUENCY kHz Switch to the 0.3-5 kHz position. Approximate output will be +10.0 volts per 5 kHz bandwidth.

Step 4
Connect circuit to be tested to Test Set and make adjustments as specified for the type of test to be made.

Step 5
Adjust kHz SET control to obtain the selected lower reference frequency.

Step 6
Set SWEEP ΔHz control for the desired maximum frequency above the reference frequency.

Step 7
Set SWEEP RATE switch to the 0.5, 2, or 4 Position. The lower frequency may be readjusted during the 10 second dwell period of the sweep.

Step 8
Adjust oscilloscope controls for a suitable display. Horizontal amplitude will be proportional to frequency and vertical amplitude will be proportional to delay. This setup will be most useful for photographic recording where camera shutter is left open for the duration of one sweep.

5.19 **FOR X-Y RECORDER**: When using the 340B with an X-Y recorder, the following steps should be followed:

Step 1
Connect ANALOG (f) output on rear terminal block, TB5, to the Recorder X input.

Step 2
Connect ANALOG (ϕ) output to the Recorder Y input.

Step 3
Set the X and Y input gain controls for phase and frequency amplitudes according to the following:

Envelope Delay approximate Amplitude:

+10 volts ±20,000 μsec for 25 Hz modulation
+10 volts ±6,000 μsec for 83-1/3 Hz modulation
+10 volts ±2,000.0 μsec for 250 Hz modulation

Frequency (approximate) Amplitude:

+10 volts/110 kHz (Analog F output)
+10 volts/5 kHz

Step 4
Set the Test Set controls as specified for the type of test to be made.

Step 5
Adjust kHz SET control to obtain the selected lower reference frequency.

Step 6
Set SWEEP ΔHz for the desired maximum frequency above the reference frequency.

Step 7
Set SWEEP RATE switch to the 0.5, 2, or 4 position. If necessary the lower frequency limit may be readjusted during the 10-second dwell time of the ramp.

Step 8
Recording will be a phase vs frequency plot.

5.20 **FOR STRIP CHART RECORDER**: When using the 340B with a strip chart recorder, the following steps should be followed:

Step 1
Connect the ANALOG (ϕ) output on rear terminal block, TB5, to the Recorder input.

Step 2
Make Test Set connections and adjustment as specified for the type of test to be made.

Step 3
Adjust kHz SET for lowest frequency as in paragraph 5.19 step 5.

Step 4
Set SWEEP ΔHz as in paragraph 5.19 step 6.

Step 5
Set SWEEP RATE switch as in paragraph 5.19 step 7.

Step 6
Adjust speed of strip chart to be consistent with sweep rate.

Step 7
Adjust input amplitude of recorder to be consistent with the Envelope Delay amplitudes in paragraph 5.19 step 3.

Frequency Counter

5.21 To use the 340B as a frequency counter, proceed as follows:

Step 1
Turn on Test Set and allow two minutes warm-up time.

Step 2
Set CHECK-COUNTER-RCVR-XMTR switch to COUNTER. The decimal point light shifts one place to the left in the COUNTER position so that frequency resolution is ±1 Hz ±1 digit.

Step 3
Connect the unknown frequency source to the COUNTER INPUT. Input must be between –10 dBm and +10 dBm (600 ohms, reference). Z IN of counter is 10K ohms shunted with 25 pF.

Step 4
Read repetition rate of input signal on the FREQUENCY display. Frequency may read up to 999.999 kHz.

External Carrier Operation

5.22 An external carrier may be used in place of the internally generated carrier. When an external carrier is to be used, proceed as follows:

Step 1
Connect output of the external carrier source to the BNC connector on the rear panel labeled EXT OSC INPUT. (Figure 2.2.)

Step 2
Set INT-EXT switch to EXT. With these connections made, all the controls of the 340B Test Set function normally except kHz SET and SWEEP. These controls are replaced by those on the external carrier source.

SECTION 6
CIRCUIT DESCRIPTION

6.01 The ten circuit boards are named according to the major function the board performs:

- A1 – Display Logic
- A2 – Divider and Control Logic
- A3 – Modulating Frequency Source
- A4 – Sign Logic, Analog Envelope Delay and Analog Frequency
- A5 – Analog To Digital Converter
- A6 – Receiver AGC, Demod and Meter Amplifier
- A7 – Output Amplifier and Meter Circuitry
- A8 – Voltage Controlled Oscillator and Sweeper
- A9 – Low Voltage Power Supply
- A10 – 160V Supply
- A11 – Analog Power Output Board

The circuits will be described in the order of signal flow rather than by numerical sequence of the circuit boards. Note that each circuit board carries a separate series of component designations.

6.02 VOLTAGE CONTROLLED OSCILLATOR, BOARD A8. The discussion for the Voltage Controlled Oscillator (VCO) and Sweeper Board is divided into two separate discussions, and is shown in Figure 6-14.

6.03 Voltage Controlled Oscillator: The carrier frequency is generated from a sawtooth wave, the frequency of which is controlled by an applied voltage. The sawtooth is processed into a triangular wave and then filtered to obtain the sine wave fundamental output.

6.04 C13 is charged to the firing voltage of the threshold detector Q22-Q25 through the current source, Q20. Charging rate is determined by the magnitude of the current from the source which is controlled by the voltage applied to the inputs of the integrated circuit operational amplifier, A1. When the threshold detector is fired and changes state, one output pulse is delivered to the J-K flip-flop, F1, through Q26, Q27. Another pulse through Q26 switches Q19 on the discharge C13. When C13 discharges, the threshold detector reverts to its original state. The voltage across C13 is thus a sawtooth, the frequency of which is controlled by the voltage applied to the inputs of A1. Voltage level to one input is controlled by kHz SET, control, R17, and the other by SWEEP (Δ Hz), control, R19, which adjusts the level of the ramp voltage out of the sweep generator. Q21 is a high impedance FET isolating stage. R56 is a calibration adjustment. Switch, S10, selects appropriate parts of the resistor networks, R93, R94 and R95, R96, R97, which controls the range of the voltage applied to A1 through the kHz SET control, R17, to determine the two frequency ranges of the VCO.

6.05 The sawtooth wave is applied to the bases of both Q11 and Q28. The output of J-K flip-flop, F1, alternately switches Q10 and Q29, thereby allowing every other ramp input to be alternately passed through Q11 and Q28. The output of Q28 is inverted through Q30 and applied to Q31 while the output of Q11 is applied directly to Q13. The output of Q13 and Q31 are combined in R36 to form a triangular wave which is applied by Q14 and Q15. The transfer characteristic of the FET, Q18, functions as a non-linear filter to the peaks of the triangular wave to form a sine wave. Q16 and Q17 serve as an isolation stage without shifting the dc level.

6.06 Sweep Oscillator: The Sweep Oscillator ramp voltage is generated by charging C3 at a linear rate through switch selected charging resistors, R9-R16 and R88-R90, from a constant current source, Q5, and then discharging it through Q3. Q3 is switched on to discharge C3 whenever the mono-stable multivibrator, Q1, Q2, is triggered. The ramp voltage thus generated is fed through the high impedance isolating stage, Q4, to the collector of Q5, as feedback to linearize the ramp, and to the input of the emitter follower stages, Q6, Q7. One output from these stages is connected to the input of the integrated circuit differential voltage comparator, A2, the output of which triggers the mono-stable multivibrator, Q1, Q2. The level at which the mono-stable multivibrator is triggered, which determines the sweep width, is set by the divider R8, R17. The ramp voltage is connected through emitter follower, Q8, to the ΔHz control, R19, which adjusts the level applied to the input of A1 to determine the sweep band width. R25 adjusts the bias to the ΔHz circuit.

6.07 OUTPUT AMPLIFIER, BOARD A7. Carrier Input to the Output Amplifier (Figure 6-13) may be either from an external source or from the VCO as selected by switch, S11. Output level of the amplifier is controlled by P_{OUT}, attenuator switch, S5, and Potentiometer, R25, which vary the input carrier level. The 150 kHz lowpass filter removes any residual harmonics or spikes from the carrier frequency generated by the VCO.

6.08 Q2, Q3 and Q16 form the phase shift network for the modulation signal. The magnitude of the modulating sine wave is adjusted by the control, R9, and

applied to the phase shift network. The phase of the modulating signal is shifted by adjustment of R39, R39-R40 or R39-R41 and C2. Q5 acts as a voltage variable resistor in the emitter of amplifier stage Q4. The output of this stage yields a signal which is proportional to the product of the carrier and the modulation frequency, hence amplitude modulation results. The modulated signal is further amplified by the integrated circuit dc amplifier A1, and power output amplifier Q9, Q10. The output is matched to various load impedances with Z_{OUT} switch, S6. The output signal is connected to the meter amplifier, Q11, through Impedance matching switch S6, rectified by CR2 and applied to Output Level meter M2. Q12-Q15 provide isolation from the power supply to this circuit.

6.09 83-1/3 Hz and 250 Hz MODULATING FREQUENCY SOURCES, BOARD A3. The standard 25 Hz modulating signal is taken directly from the Divider and Control Logic board (Figure 6-8), A2, through the 25 Hz lowpass filter, (FL1). The other modulation frequencies are derived from a 1 kHz output of the Divider and Control Logic board and are divided down in the two A3 boards to derive the required frequencies Figure 6-9). On the 250 Hz board the 1 kHz output is divided twice with the J-K flip-flops, F1, F2, to produce a 250 Hz output. This output is amplified by Q2 and matched to the 250 Hz output lowpass filter by Q3. On the 83-1/3 Hz board, four J-K flip-flops, F1-F4, using two feedback loops are necessary to produce the 83-1/3 Hz output. This output is amplified by Q2 and matched to the 83-1/3 Hz output lowpass filter by Q3. The proper reference modulation frequency is selected from either boards A3 or A2 by MOD FREQ switch. S8 and connected to board A4.

6.10 RECEIVER, AGC, DEMODULATOR AND METER AMPLIFIER, BOARD A6. Signal input passes through the line impedance matching network controlled by the Z_{IN} switch, S1, through the Receiver Attenuator network (Figure 6-12) controlled by the P_{IN} switch, S2, to input amplifier, Q2, the gain of which is controlled by an AGC circuit. The output of Q2 is amplified by Q6, and applied to Phase-Splitter Q7 and the output of Q7 applied to a full wave demodulator, CR4, CR5.

6.11 The gain of Q2 is controlled in the following manner: An output is taken from Q8 and passed through a parallel T filter to remove the modulation but retain the dc component of the detector signal. A high output impedance for the filter is furnished by a Darlington stage of Q10 and Q11. The dc output is applied to a matched pair differential amplifier Q5. Bias on one base of the differential amplifier is adjustable by means of R6 to control the AGC level. Residual high frequency components of the carrier are removed from the differential output signal by C3. The dc level is inverted by Q4 and applied to the gate of Q3. Q3 is an insulated gate FET which functions as a voltage variable resistance in the emitter of Q2, thereby controlling the gain of the input stage.

6.12 The regulated signal from Q8 passes through emitter following Q9, and then through the proper switch selected Demodulation Filter, 25, 83-1/3 or 250 Hz. The input to A1 is fed through R29 by-passed by C11 and R28, thus yielding significant gain at modulation frequencies and good dc stability. The demodulated signal out of A1 is applied to the zero crossing threshold detector Q16-Q19. This detector very accurately detects the zero crossing point of the applied signal to produce a square wave output with a leading edge accurately referenced to the envelope of the received signal. Both a true and complemented output, designated B and $\overline{B}$, are coupled out through Q14 and Q15 to the phase and sign logic circuits on Board 4. The return reference output is taken from A1 and fed through R33 to S12.

6.13 The meter and analog frequency signals are amplified to the proper level by a separate amplifier, A2. Amplifier gain is set with R50. One output is ac coupled to the meter rectifier, CR6. The amplifier output is also directly connected to the Analog frequency conditioning circuits on board A4 through CHECK-COUNTER-RCVR-XMTR switch, S4.

6.14 Also mounted on this board are the Schmitt Trigger circuitry, Q22, Q23 and output amplifier, Q24, for the 1 MHz counter.

6.15 SIGN LOGIC, ANALOG PHASE AND ANALOG FREQUENCY, BOARD A4. Three functions are performed on this board (Figure 6-10). One, magnitude and sign of the envelope delay are determined in the Sign and Envelope Delay logic circuits. Two, the envelope delay digital output is converted to an analog output; and three, the frequency, either transmitted or received, is converted to an analog output.

6.16 Envelope Delay Magnitude and Sign: In order to compare the envelope delay at each zero crossing of the reference A and the returned signal B, the following logic function must be realized: $M = A\overline{B} + \overline{A}B$. Envelope magnitude logic, G1, G2, accomplished this purpose, to produce M and $\overline{M}$ (magnitude of envelope delay). Sign determination is accomplished by establishing the relative positions A and B. This is mechanized with a J-K flip-flop, F1 and inverter, Q1.

6.17 **Analog Envelope Delay**: The magnitude of envelope delay in digital form, (pulse width, M and $\overline{M}$ proportional to delay), is converted to an analog signal. Transistors Q2 and Q3 invert output $\overline{M}$, then Q4 buffers the signal. The parallel T filter composed of R11, R12, R13, C14 and C15 filters out the 50 Hz signal component, then emitter follower buffers the signal through another filter composed of R15, R16, C16 and C17. Inverting amplifier A2 produces a positive voltage (+10V for 20,000 microseconds). The digital counter produces the sign information.

6.18 **Analog Frequency**: Either the received or transmitted signal may be connected to the input of the analog frequency circuit by the CHECK-COUNTER-RCVR-XMTR switch, S4. The signal is applied to the threshold detector Q17-Q19 and Q21; one output, through Q16 is connected to the control logic circuits to be counted, while the other output through Q20 is used to generate the analog frequency output. The output of Q20 is differentiated to yield a sharp pulse. The negative portion of the pulse is removed by CR1 and the positive spike applied to the input of the one-shot multivibrator, Q22, Q23 through CR2. The output of the one-shot is a train of pulses of constant width and amplitude having the same frequency as the input signal. These pulses are amplified, buffered, and inverted by Q24-Q26, which apply the signal to the R.C. filter, R60, C23, R63 and C24. Amplifier A3 inverts the dc output of the filter, producing +10 volts per 5 kHz band pass when FREQUENCY kHz Switch is in the 0.3-5 kHz Position and +10 volts per 110 kHz when that switch is in the 5-110 position.

6.19 **ANALOG TO DIGITAL CONVERTER, BOARD A5**. The complement of envelope delay output, $\overline{M}$, from board A4 is inverted by Q1 to yield M and is filtered by the network R7, R10, C3 to obtain a dc voltage level proportional to the magnitude of the envelope delay. This dc output is applied to an inverting amplifier, A1 (μA702). Zero off-set is adjusted by applying a stable dc voltage to the non-inverting input of A1 through R11. Full count calibration is adjusted with R3, R5. Thus there exists at the output of Q3 a stable, inverted dc level directly proportional to magnitude of envelope delay. (See Figure 6-11).

6.20 The following circuits perform the voltage-to-frequency conversion. Dc amplifier A2 (μA709) is connected as an integrator, C12 being the integrating capacitor. A negative voltage at the input of the integrator generates a positive going ramp output which is applied through Q4 to the input of threshold detector, A3, (μA710). The ramp triggers the detector at a fixed positive voltage point. The pulse out of the threshold detector in turn triggers the one-shot multivibrator, Q8, Q9 and the resulting pulse out of the one-shot is applied to the input of A2 through Q6, Q7 to discharge the capacitor C12 and restart the ramp output of A2.

6.21 In order to cancel the effects of power supply variations, the area of the pulses applied through R25 must be proportional to the power supply voltage. This is accomplished by feeding a constant width pulse into Q7. Constant width is attained with the aid of Q10 and Q11. Collector current out of Q10 is directly proportional to power supply voltage. The voltage at the collector of Q9 is likewise proportional to the supply voltage. These two effects cancel one another and yield a constant width pulse into Q7. A more negative voltage at the input of A2 increases the slope of the ramp, which increases the rep-rate of the output pulses from A3 so that pulse frequency is directly proportional to input voltage. Frequency range is from 25 Hz to 500 kHz. The output of A3 is connected to the magnitude of envelope delay input of the control logic on board A2. Q2, Q5 are used for 6 volt zener diode regulators.

6.22 The discussion for the Divider and Control Logic Board (A2) is divided into two separate discussions, and is shown in Figure 6-8.

6.23 **Divider**: A very stable 1 MHz crystal oscillator drives the divider. To maintain high frequency stability the crystal is mounted in a temperature controlled oven which is on whenever the power cord is plugged into the ac line.

6.24 The output of the 1 MHz oscillator passes through four integrated circuit decade dividers, M2-M5, to divide down to 100 Hz, and then through two binary dividers, F1, F2 to produce 50 Hz and 25 Hz outputs for control and modulation.

6.25 A 1 MHz output is coupled out through Q17 for the magnitude of envelope delay test and a 100 kHz output from M2 for the frequency test. The 1 kHz output for the generation of the 83-1/3 Hz and 250 Hz modulation frequencies is taken directly from the output of M4.

6.26 A 50 Hz output from F1 in the divider is connected directly to the control logic circuitry and is used as the clock signal in forming the required gate, transfer and reset functions. This output is also divided down by the decade divider, M6, to provide the time base when the 340B is used in the counter mode.

6.27 **Control Logic**: The sequence of gates and pulses required during a single count period is as follows

(Figure 6-2): A 40 millisecond count gate for envelope delay, immediately followed by an envelope delay count store pulse; in the middle of the 20 millisecond interval between envelope delay and frequency count a counter reset pulse; at the end of the 20 millisecond interval a 100 millisecond count gate for frequency immediately followed by a frequency count store pulse; in the middle of the 40 millisecond interval following the frequency gate a counter reset pulse; at the end of the 40 millisecond interval the sequence repeats. In this manner the counter is shared between Envelope Delay and Frequency with five sampling periods per second provided for each.

6.28 The major part of the control logic circuitry is made up of integrated micrologic circuits with individual transistors used as buffers or inverters. Two micrologic units are used: The CμL 958, which is a decade counter; and the μL914, a dual two input gate, which is connected in three different ways: G1, G2, G4, G5 "nand" gates (all inputs low, output high), G6 as an R-S flip-flop and G3, G7, G8 as one-shot multivibrators.

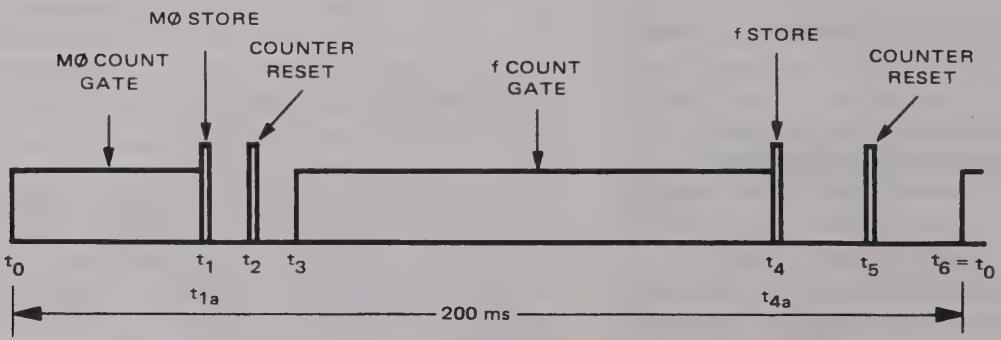
6.29 When a 50 Hz control signal is connected to the count input of M1 CμL 958) four outputs are generated: Z1 which is alternately high and low for 20 millisecond intervals; Z2 which is alternately high and low for 40 millisecond intervals; Z4 which is high for 80 ms, low for 80 ms, high for 40 ms and then repeats; and Z8 which is high for 160 ms and low for 40 ms and then repeats (Figure 6-2) . Using these outputs and the 50 Hz signal C_L, four logic functions are generated (Figure 6-3).

$$f_2 = Z_1 Z_4 \bar{Z}_2$$
$$f_3 = f_2 \bar{C}_L$$
$$f_5 = \bar{Z}_8$$
$$f_6 = \bar{Z}_1 \bar{Z}_8$$

By a proper combination of these functions, all of the gates and pulses in Figure 6-1 can be derived.

6.30 **DISPLAY LOGIC, BOARD A1.** The counter board, 1-5, are made up of five identical sections, each containing one CμL 958 Decade Counter, two CμL 959 Buffer-Storage Units and two CμL 960 Decade/ Drivers. Counter board 6 contains only CμL 958, one CμL 960. The counter outputs are connected to both storage units, however the storage units accept count information only when gated on by the store pulse from the control logic circuits, thereby assuring that the count information is entered into the proper storage units. Outputs of the storage units are connected to the Decade/Drivers which operate the Nixie readout tubes (Figure 6-7).

6.31 The Decade Counters use the 8-4-2-1 binary code, the count being limited to ten by internal feedback loops which reset the counter, and the ten count is transferred to the next higher decade by the external carry connection. Count information is transferred to the storage units and to the Decade/Drivers in the binary code form. A matrix in the Decade/Driver units decodes from binary to decimal, providing ten outputs to operate the ten elements of the Nixie tubes.



t_0	– 0 ms	Envelope Delay (MØ) count gate opens	t_4	– 160 ms	Frequency count gate closes
t_1	– 40 ms	Envelope Delay count gate closes	t_{4a}	– 160+ ms	Frequency store pulse
t_{1a}	– 40+ ms	Envelope Delay count store pulse	t_5	– 180 ms	Counter reset pulse
t_2	– 50 ms	Counter reset pulse	t_6	– 200 ms	End of count period sequence
t_3	– 60 ms	Frequency (f) count gate opens	$t_6 = t_0$		Start next count period sequence

Figure 6-1. Control Logic Pulse Timing

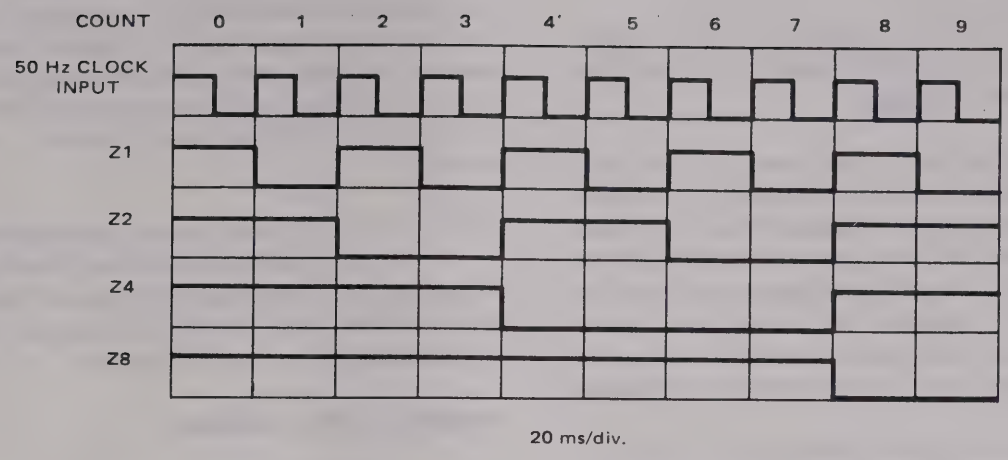


Figure 6-2. Output Waveforms, M5

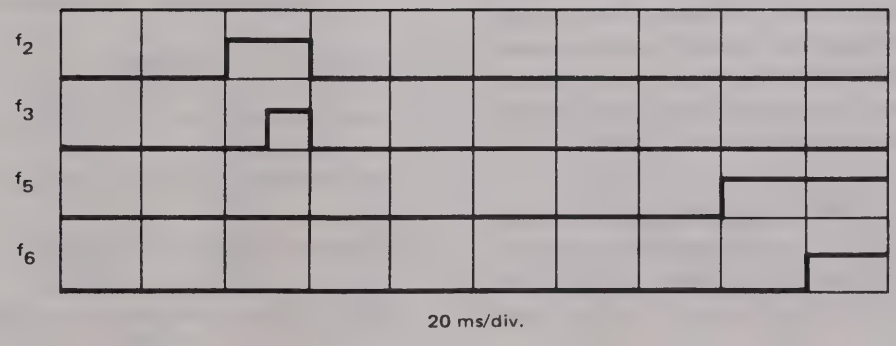


Figure 6-3. Logic Functions

6.32 A voltage of approximately 160V dc is applied to the anode of each Nixie tube through an 8.2K resistor. The cathode element of the tube is turned on by bringing the cathode potential down to a few volts above ground.

6.33 Resistors R1-R8 on each board section are pull-up resistors to provide a positive off (high) when the true (low) signal is not present.

6.34 Two decimal point lights, mounted in the FREQUENCY counter, are controlled by the S4A deck of the function switch. These decimal point lights change in accord with the proper resolution of the counters. A single decimal point light in the envelope DELAY readout is controlled by the S8G deck of the MOD FREQ switch. This decimal point light changes in the 250 Hz position where 0.1 μsec resolution is attained.

6.35 There are two power supply boards used in the 340B, one Low Voltage Power Supply and one +160 Volt Supply (Figure 6-15).

6.36 **LOW VOLTAGE POWER SUPPLY, BOARD A9.** Four separate low voltage power supplies are used in the Set, and each supply is separately regulated. One +12 volt supply, used for the 1 MHz oscillator B+ power and heater, and for the decimal point lamps. This supply is not switch controlled, but is on whenever the ac line cord is plugged into an ac source.

6.37 The bridge rectifier diodes for this supply and for the +3.6V digital circuits supply are mounted on the chassis outside the boards to provide them with a heat sink. The bridge rectifier diodes of the other +12V and the −12V supplies are mounted on the circuit boards since the current requirement from these supplies is relatively small. The series regulator and companion driver transistors for these four supplies are mounted on the rear panel to provide an adequate heat sink. In the regulator control amplifier circuits mounted on the board, transistors Q4, Q8, Q12, Q14 function as voltage reference diodes.

6.38 **+160 VOLT SUPPLY, BOARD A10.** This board contains the bridge rectifier and voltage reference transistor for the 160V supply, the series regulator, Q9, being mounted on the chassis adjacent to the board (Figure 6-16).

6.39 A single transformer, T1, having five separate secondaries, furnishes the correct voltage for each of the power supplies. The primary of this transformer is in two sections. These sections may be switch selected by S13 for either a 115V or a 230V ac power line source.

6.40 **ANALOG POWER OUTPUT, BOARD A11.** The Analog Power Output circuit (Figure 6-17) is a printed circuit board operating as an analog to digital converter with a dc gain of approximately 4. A 50% modulated signal is received from the receiver board (A6) and is applied to the input of the Analog Power board. This signal is converted to a dc voltage which is proportional to the input power. The analog power is provided through the output, to a terminal block (TB5-2), where the subsequent level can then be fed to a strip chart recorder.

6.41 A 20 dB dynamic range of approximately .6V to 10 volts can thus be obtained. This corresponds to the Receiver Power Meter (M1) range of −20 dBm to 0 dBm (−10 dBm set to +3.0 Vdc) as indicated when the P IN attenuator is set to the 0 dB position.

Integrated Circuit Modules

6.42 **Logic IC Modules:** Five different types of Integrated Circuit RTL (Resistor Transistor Logic) logic modules are used in the 340B.

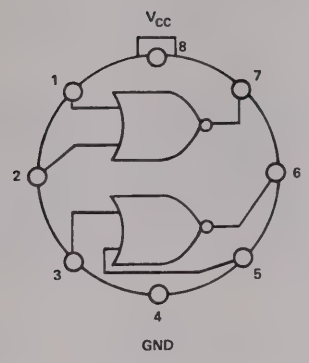
6.43 The μL914 has two independent gates mounted in the same enclosure. (Figure 6-4a). Each gate performs either the NAND or NOR functions. The NAND function is positive logic A $\overline{B}$, *that is,* with *both* inputs low, the output is high. The NOR function is negative logic A + B, that is, if either input is high the output is low.

6.44 The μL923 is a single J-K Flip-Flop. The functioning of this unit is described by the following table: (Figure 6-4b.) The unit is reset to the state: pin 7 high (pin 5 low), by applying a high level pulse to pin 6.

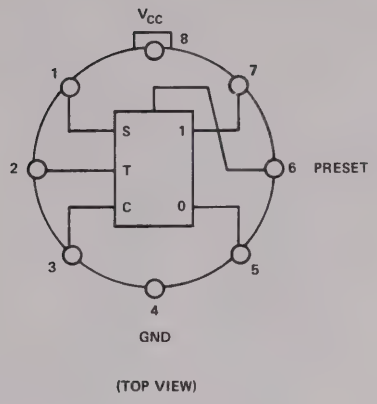
J SET (S) (1)	K CLEAR (C) (3)	OUTPUT (1) (7)
t = n		t = n + 1
H	H	X^n
H	L	H
L	H	L
L	L	$\overline{X^n}$

Where

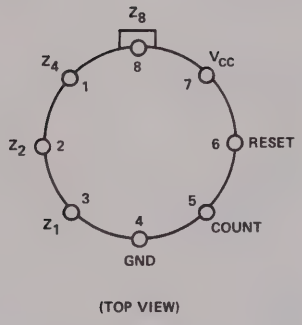
X = The output state at time n.
n = The time just previous to a negative trigger at pin 2.
H = High Level
L = Low Level

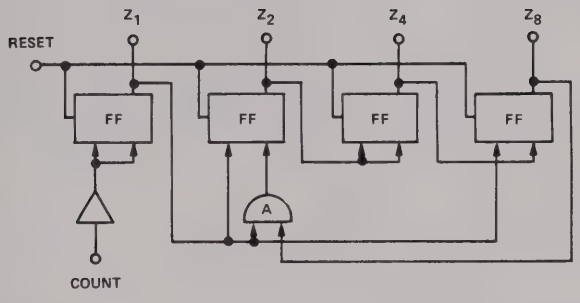


A
μL914 Dual Two Input Gate

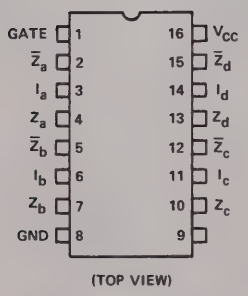


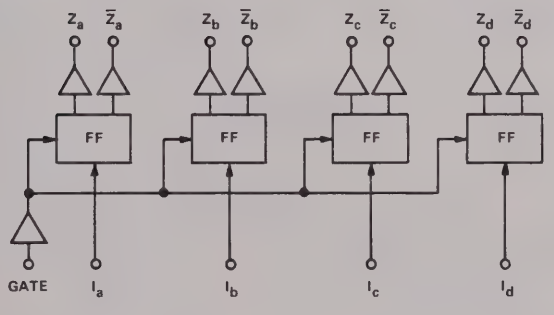
B
μL923 J-K Flip-Flop





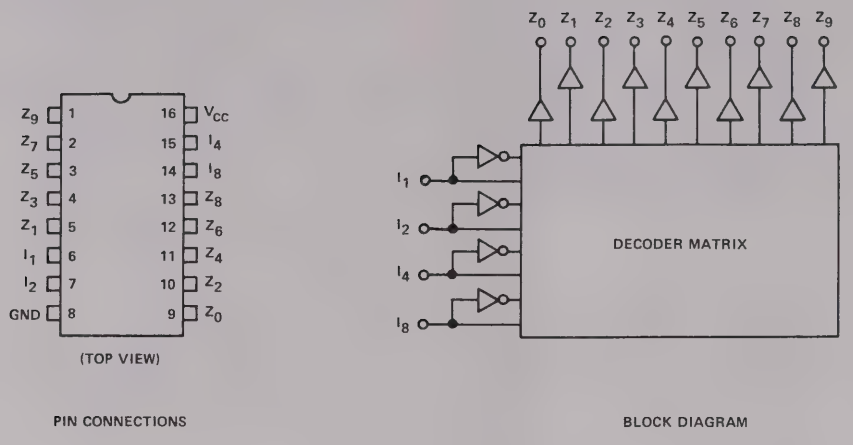
C
CμL958 Decade Counter



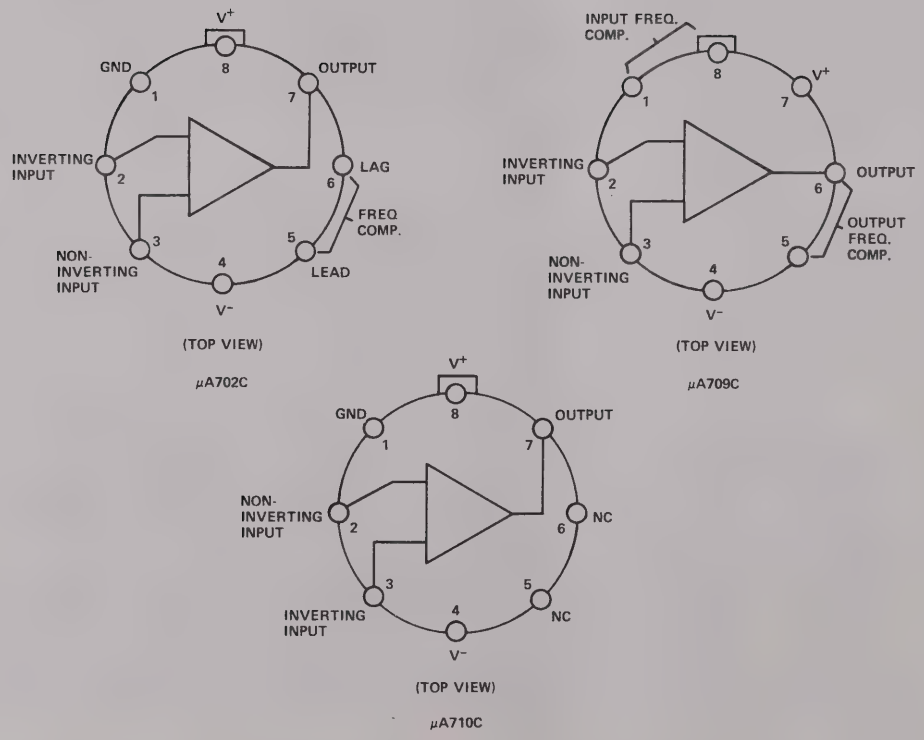


D
CμL959 Buffer-Storage Unit

Figure 6-4. Integrated Circuit Diagram (Sheet 1 of 2)



E
CμL960 Decimal Decoder/Driver



F
Integrated Circuit Amplifiers

Figure 6-4. Integrated Circuit Diagram (Sheet 2 of 2)

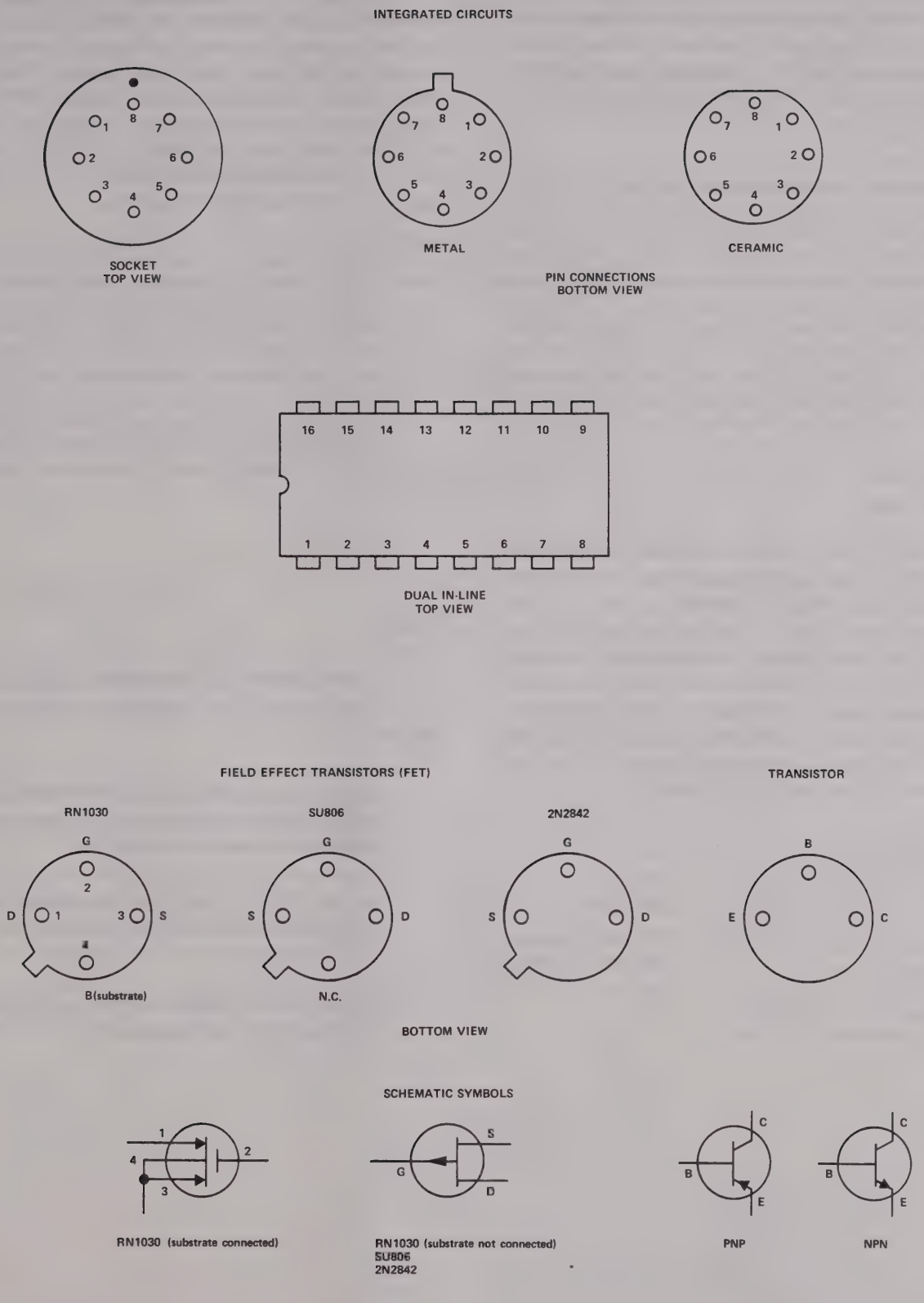


Figure 6-5. Integrated Circuit and Transistor Pin Connection Diagrams

6.45 The CμL 958 is a complete decade counter (Figure 6-4c) made up of four cascaded binary flip-flops, modified by a feedback loop for a decade count in the 1-2-4-8 binary code. The circuit is reset to zero count (all outputs high) by a high level pulse applied to the reset pin. The table of output states is as follows:

COUNT

	0	1	2	3	4	5	6	7	8	9
Z_1	H	L	H	L	H	L	H	L	H	L
Z_2	H	H	L	L	H	H	L	L	H	H
Z_4	H	H	H	H	L	L	L	L	H	H
Z_8	H	H	H	H	H	H	H	H	L	L

Where
H = High Level
L = Low Level

6.46 The CμL 959 is made up of four gate-latch data input circuits and a common gate driver. (Figure 6-4d). Information which is present at the four data inputs enters the latches during the interval of a load command (gate low) applied to the gate input terminal. With gate high, information is stored until a subsequent load command permits a change. Input information is supplied by the CμL 958 Decade Counter. The truth table for each of the data input storage circuits is: The zero count state is: all outputs ($Z_o - Z_d$) high.

TRUTH TABLE

GATE	1	Z	$\overline{Z}$
L	L	L	H
L	H	H	L
H	Any	Q	$\overline{Q}$

H = High Level
L = Low Level
Q = The state assumed prior to "Gate High" is maintained

6.47 The CμL 960 is a Decimal Decoder/Driver (Figure 6-9e) which accepts 1-2-4-8 binary coded decimal inputs and produces ten mutually exclusive outputs which directly control the ionizing potential of the elements of the Nixie tubes in the readout. The binary coded decimal information from the CμL 959 Buffer-Storage unit is decoded and applied to the proper terminal of a Nixie tube. For the input (I_1, I_2, I_4, I_8) coding shown in the truth table below, only one of the outputs ($Z_0 - Z_9$) will be low (ON) at any time.

I_1	H	L	H	L	H	L	H	L	H	L
I_2	H	H	L	L	H	H	L	L	H	H
I_4	H	H	H	H	L	L	L	L	H	H
I_8	H	H	H	H	H	H	H	H	L	L
	Z_0	Z_1	Z_2	Z_3	Z_4	Z_5	Z_6	Z_7	Z_8	Z_9

H = High Level

L = Low Level

Output

6.48 **AMPLIFIER IC MODULES:** Three different Integrated Circuit Amplifier modules are used in the 340B.

1. The μA 702C is a High Gain, Wide Band operational amplifier with a connection for external frequency compensation. See Figure 6-4f.

2. The μA 709C is a High Gain operational amplifier, having external connections for input and output frequency compensation. See Figure 6-4f.

3. The μA 710C is a Differential Comparator and operational amplifier. See Figure 6-4f.

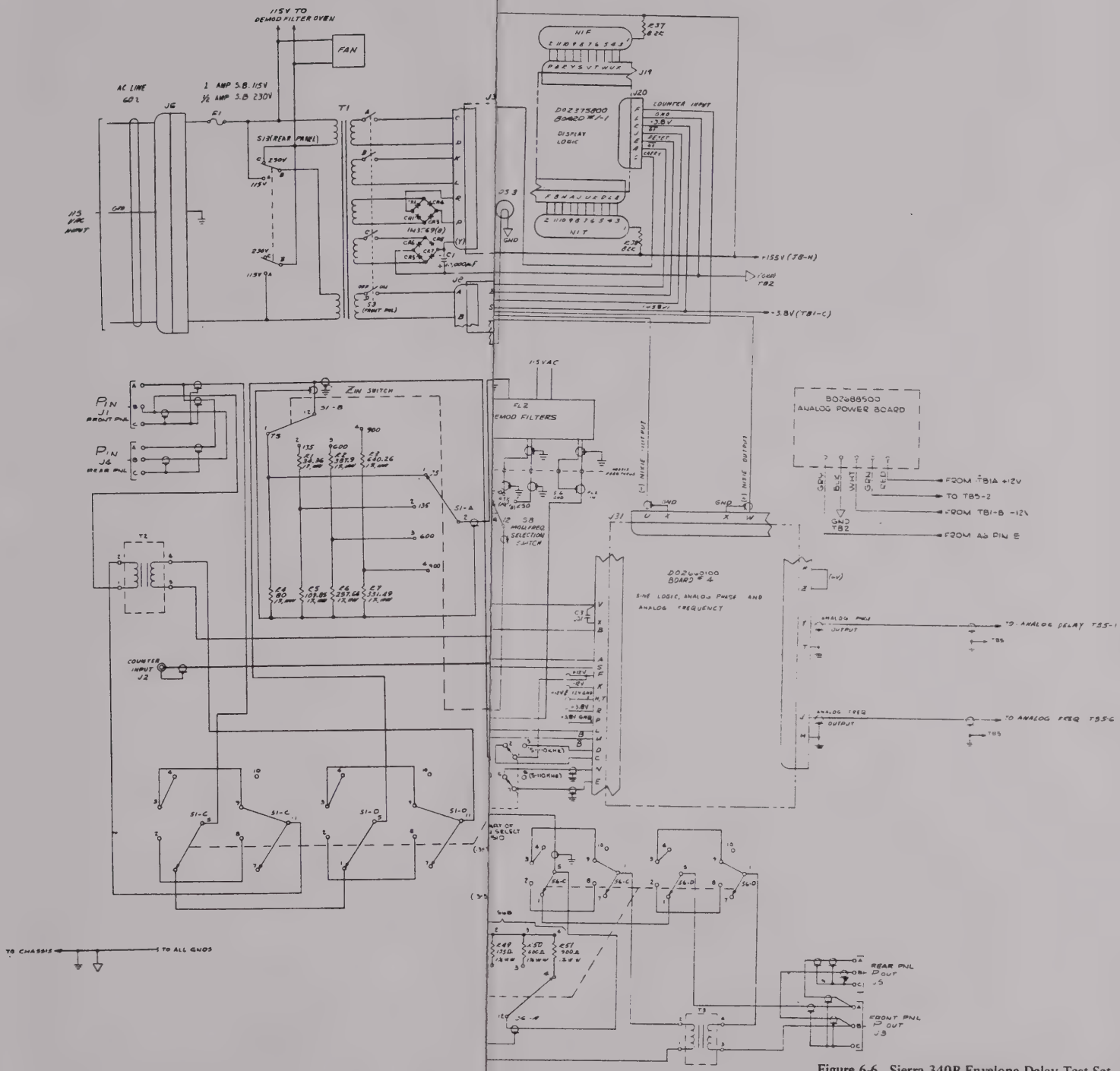


Figure 6-6. Sierra 340B Envelope Delay Test Set Schematic Diagram

6.45 The CμL 958 is a complete decade counter (Figure 6-4c) made up of four cascaded binary flip-flops, modified by a feedback loop for a decade count in the 1-2-4-8 binary code. The circuit is reset to zero count (all outputs high) by a high level pulse applied to the reset pin. The table of output states is as follows:

COUNT

	0	1	2	3	4	5	6	7	8	9
Z_1	H	L	H	L	H	L	H	L	H	L
Z_2	H	H	L	L	H	H	L	L	H	H
Z_4	H	H	H	H	L	L	L	L	H	H
Z_8	H	H	H	H	H	H	H	H	L	L

Where

H = High Level

L = Low Level

6.46 The CμL 959 is made up of four gate-latch data input circuits and a common gate driver. (Figure 6-4d). Information which is present at the four data inputs enters the latches during the interval of a load command (gate low) applied to the gate input terminal. With gate high, information is stored until a subsequent load command permits a change. Input information is supplied by the CμL 958 Decade Counter. The truth table for each of the data input storage circuits is: The zero count state is: all outputs ($Z_o - Z_d$) high.

TRUTH TABLE

GATE	1	Z	$\overline{Z}$
L	L	L	H
L	H	H	L
H	Any	Q	$\overline{Q}$

H = High Level
L = Low Level
Q = The state assumed prior to "Gate High" is maintained

6.47 The CμL 960 is a Decimal Decoder/Driver (Figure 6-9e) which accepts 1-2-4-8 binary coded decimal inputs and produces ten mutually exclusive outputs which directly control the ionizing potential of the elements of the Nixie tubes in the readout. The binary coded decimal information from the CμL 959 Buffer-Storage unit is decoded and applied to the proper terminal of a Nixie tube. For the input (I_1, I_2, I_4, I_8) coding shown in the truth table below, only one of the outputs ($Z_0 - Z_9$) will be low (ON) at any time.

I_1	H	L	H	L	H	L	H	L	H	L
I_2	H	H	L	L	H	H	L	L	H	H
I_4	H	H	H	H	L	L	L	L	H	H
I_8	H	H	H	H	H	H	H	H	L	L
	Z_0	Z_1	Z_2	Z_3	Z_4	Z_5	Z_6	Z_7	Z_8	Z_9

H = High Level

L = Low Level

Output

6.48 **AMPLIFIER IC MODULES**: Three different Integrated Circuit Amplifier modules are used in the 340B.

1. The μA 702C is a High Gain, Wide Band operational amplifier with a connection for external frequency compensation. See Figure 6-4f.

2. The μA 709C is a High Gain operational amplifier, having external connections for input and output frequency compensation. See Figure 6-4f.

3. The μA 710C is a Differential Comparator and operational amplifier. See Figure 6-4f.

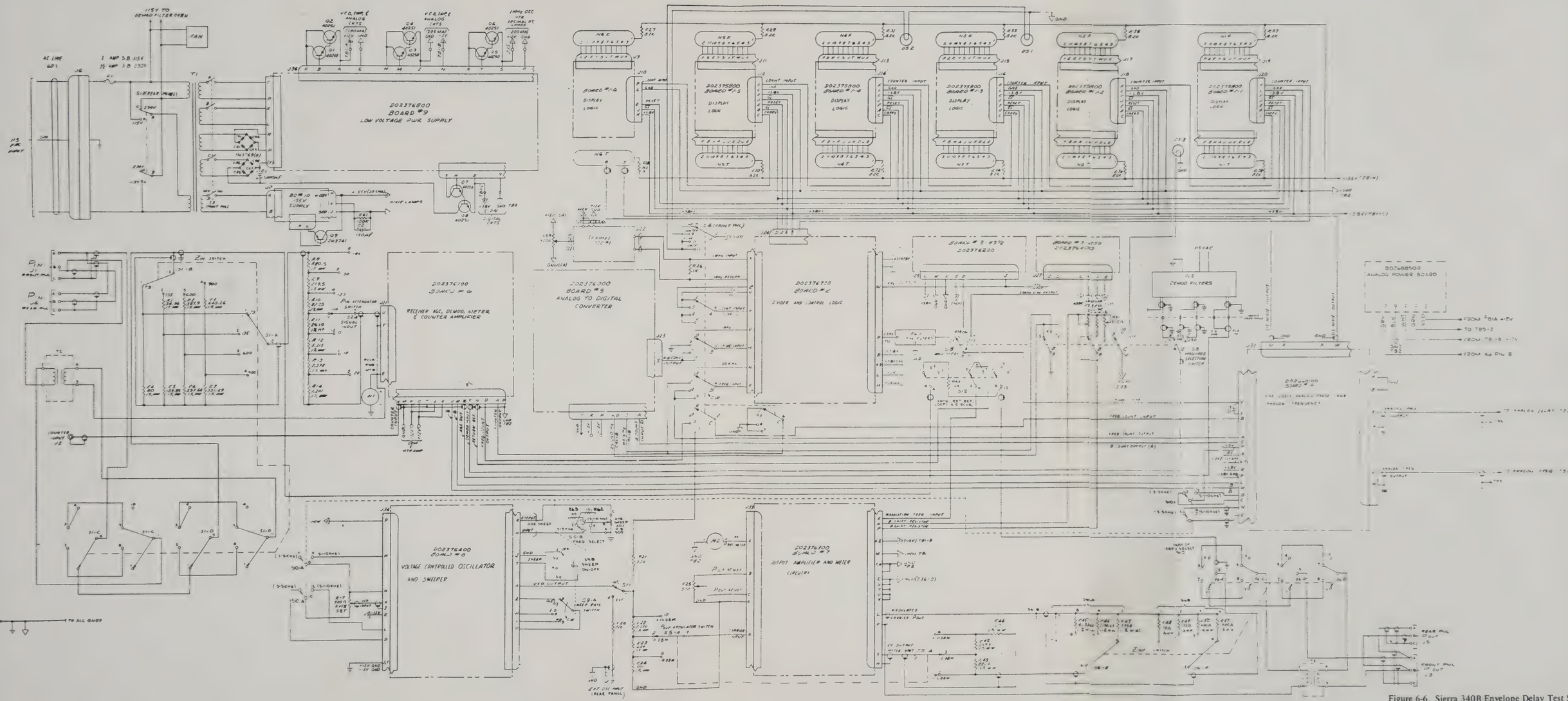


Figure 6-6. Sierra 340B Envelope Delay Test Set Schematic Diagram

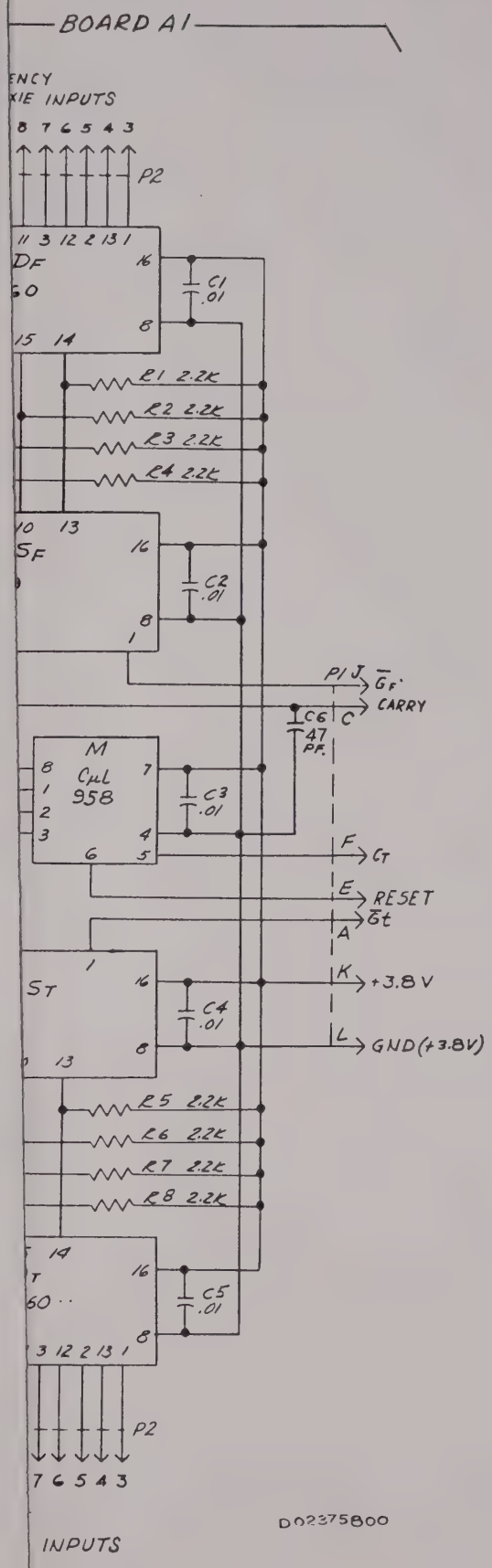


Figure 6-7. Display Logic, Board A1

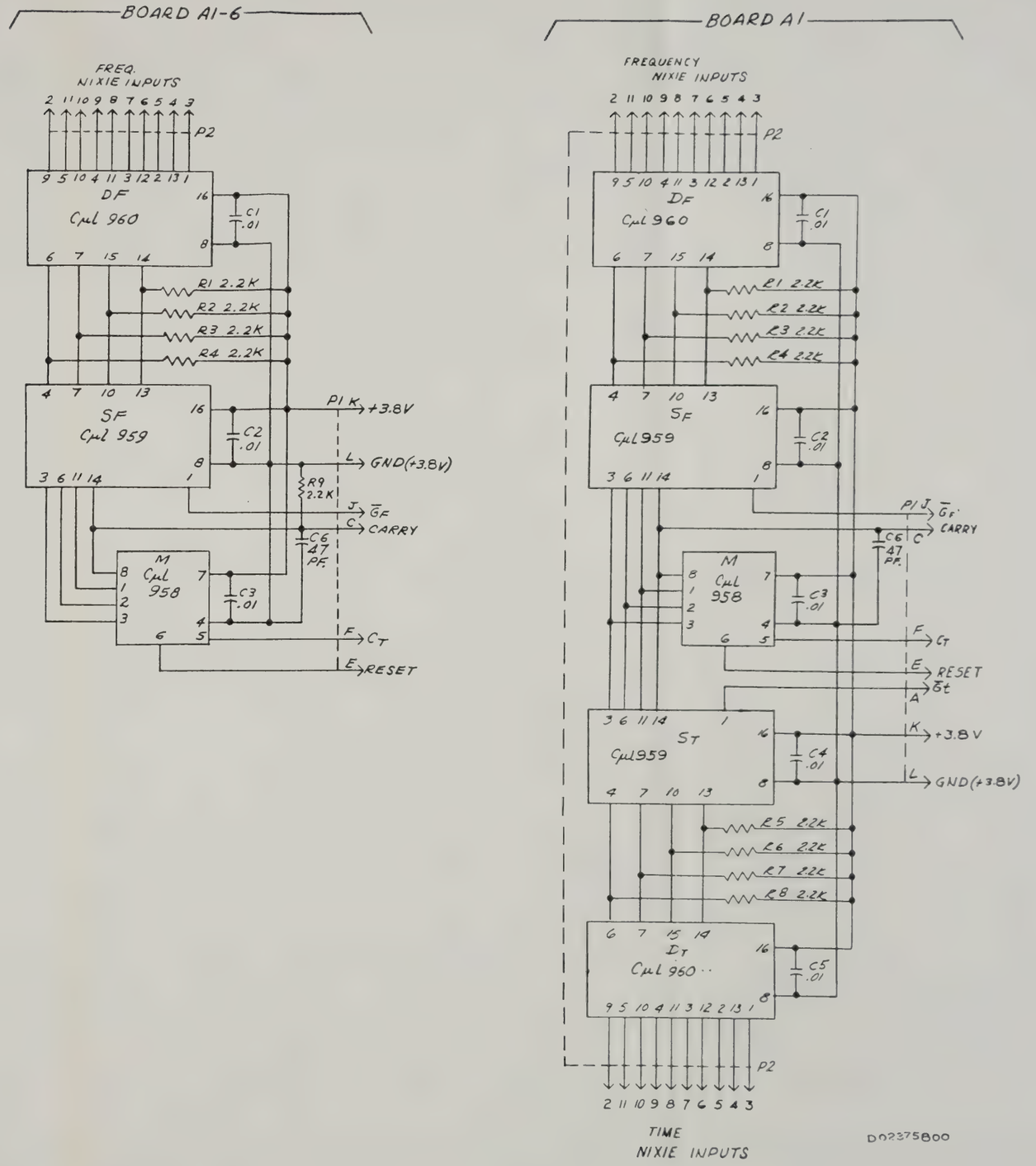


Figure 6-7. Display Logic, Board A1

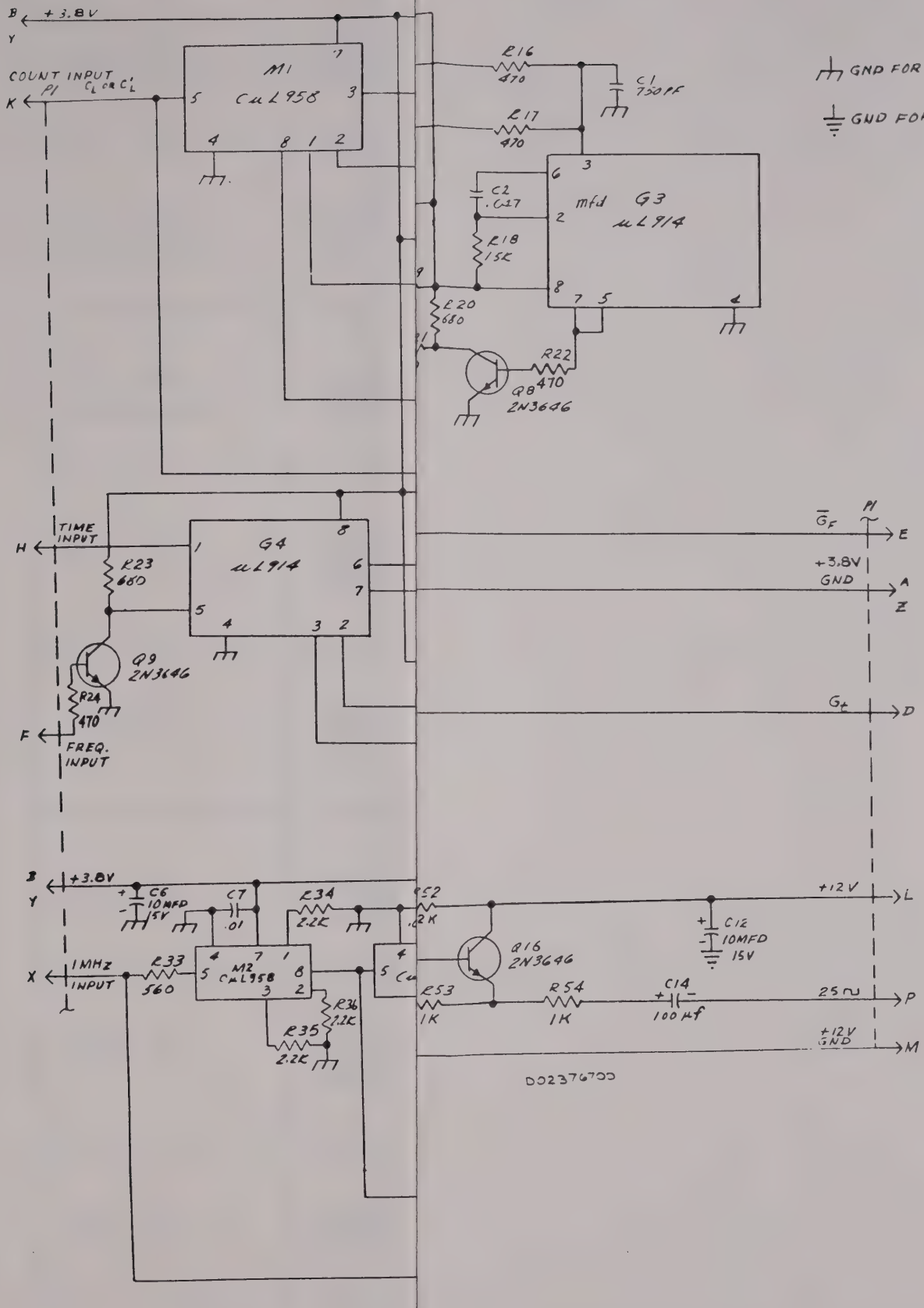


Figure 6-8. Divider & Control Logic, Board A2 (Sheet 1 of 2)

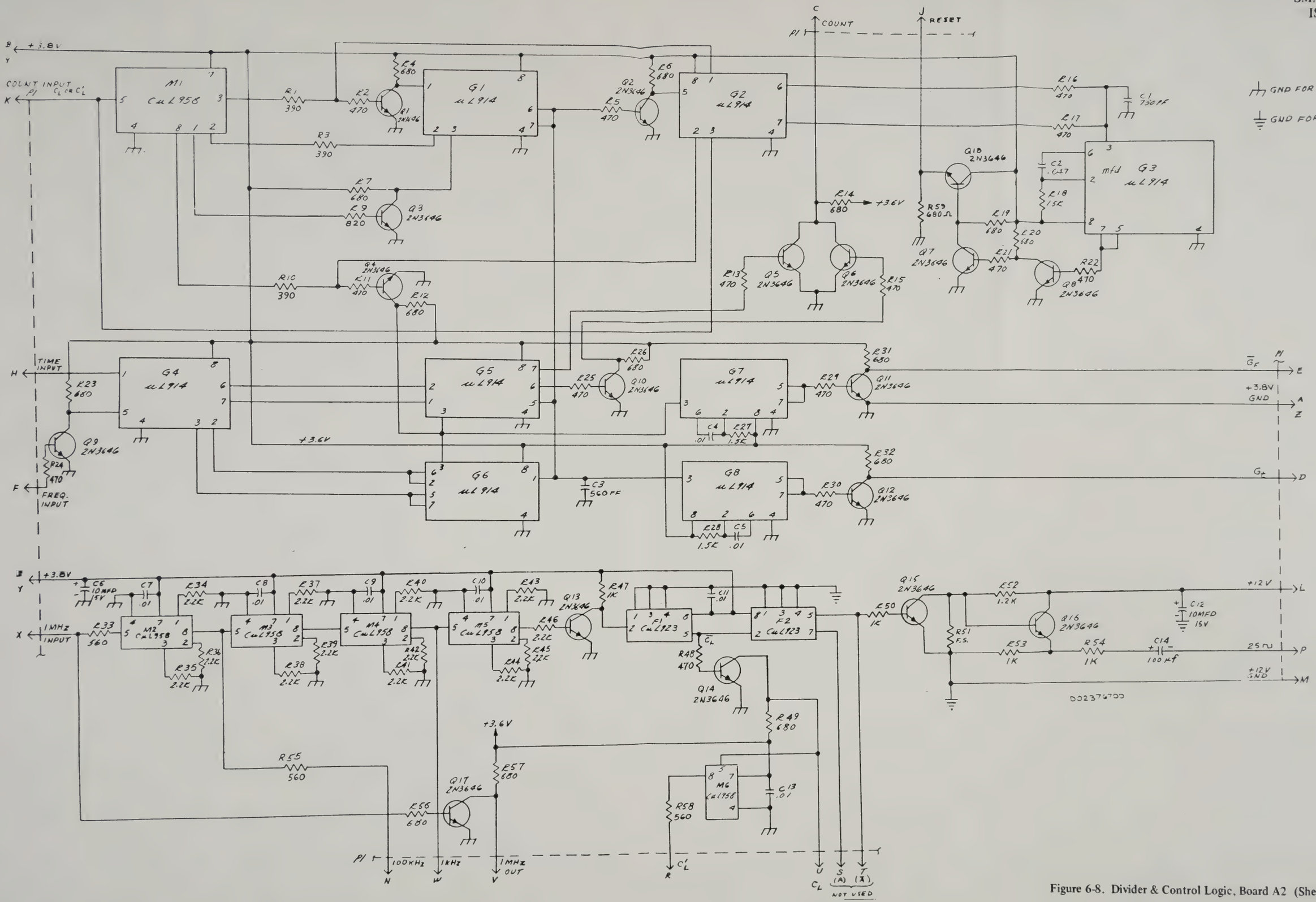


Figure 6-8. Divider & Control Logic, Board A2 (Sheet 1 of 2)

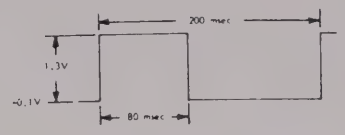
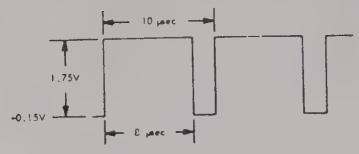
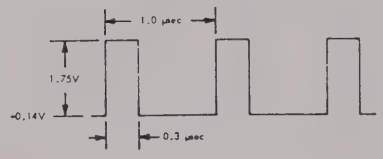
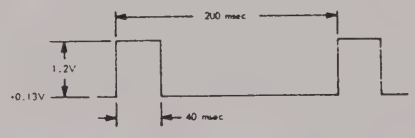
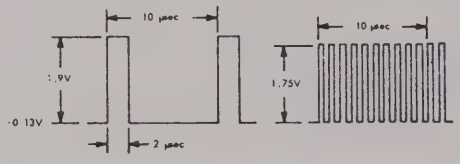
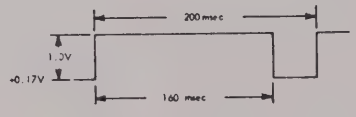
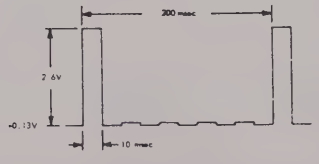
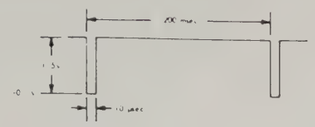
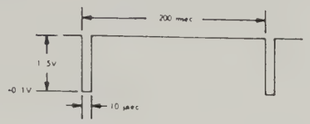
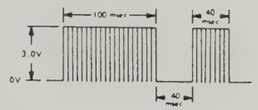
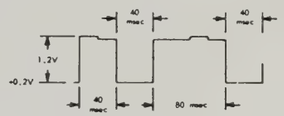
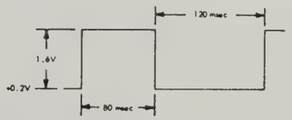
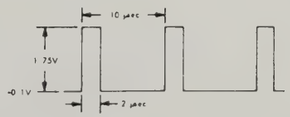
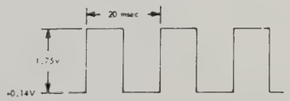
Test Point	Contr	Waveform	
Pin E, J24 (Collector Q11)	Functio CHECK		i.
Pin D, J24 (Collector Q12)	Functio CHECK		j.
Pin C, J24 (Collector Q5)	Functio CHECK		k.
Pin 6, G1	Functio CHECK		l.
Pin 2, G1	Functio CHECK		m.
Pin 3, G1	Functio CHECK		n.
Pin 5, G4	Functio CHECK		o.
Pin 1, G1	Functio CHECK		p.

Figure 6-8. Divider & Control Logic, Board A2
(Sheet 2 of 2)

Test Point	Control Setting	Waveform
Pin E, J24 (Collector Q11)	Function switch in CHECK position	 a.
Pin D, J24 (Collector Q12)	Function switch in CHECK position	 b.
Pin C, J24 (Collector Q5)	Function switch in CHECK position	 c.
Pin 6, G1	Function switch in CHECK position	d.
Pin 2, G1	Function switch in CHECK position	 e.
Pin 3, G1	Function switch in CHECK position	 f.
Pin 5, G4	Function switch in CHECK position	 g.
Pin 1, G1	Function switch in CHECK position	 h.

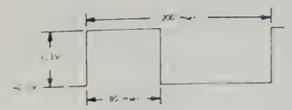
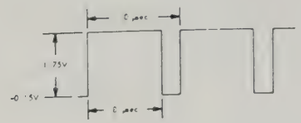
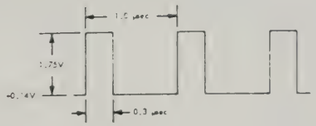
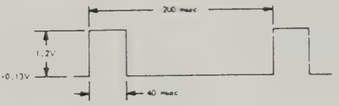
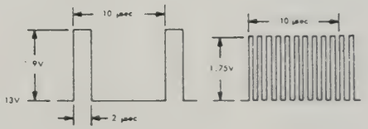
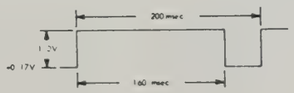
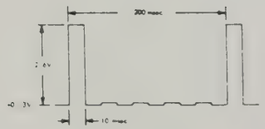
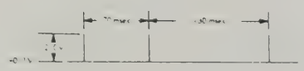
Test Point	Control Setting	Waveform
Pin 3, G4	Function switch in CHECK position	 i.
Pin 6, G4	Function switch in CHECK position	 j.
Pin 7, G4	Function switch in CHECK position	 k.
Pin 3, G5	Function switch in CHECK position	 l.
Pin 7, G5	Function switch in CHECK position	 m.
Pin 2, G2	Function switch in CHECK position	 n.
Pin 6 & 7, G2	Function switch in CHECK position	 o.
Pin J, J24	Function switch in CHECK position	 p.

Figure 6-8. Divider & Control Logic, Board A2
(Sheet 2 of 2)

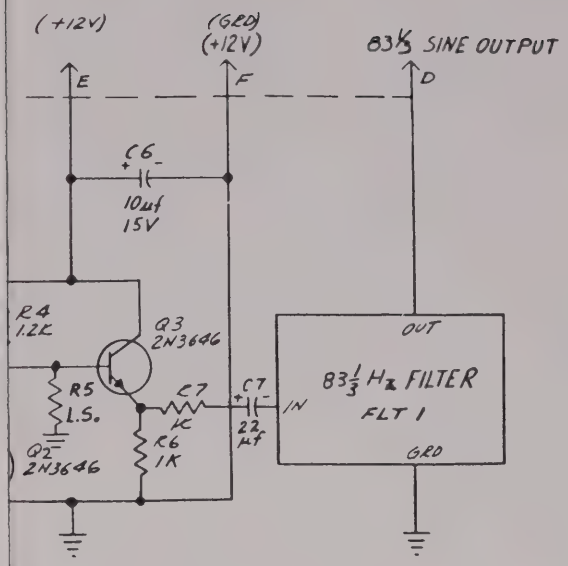
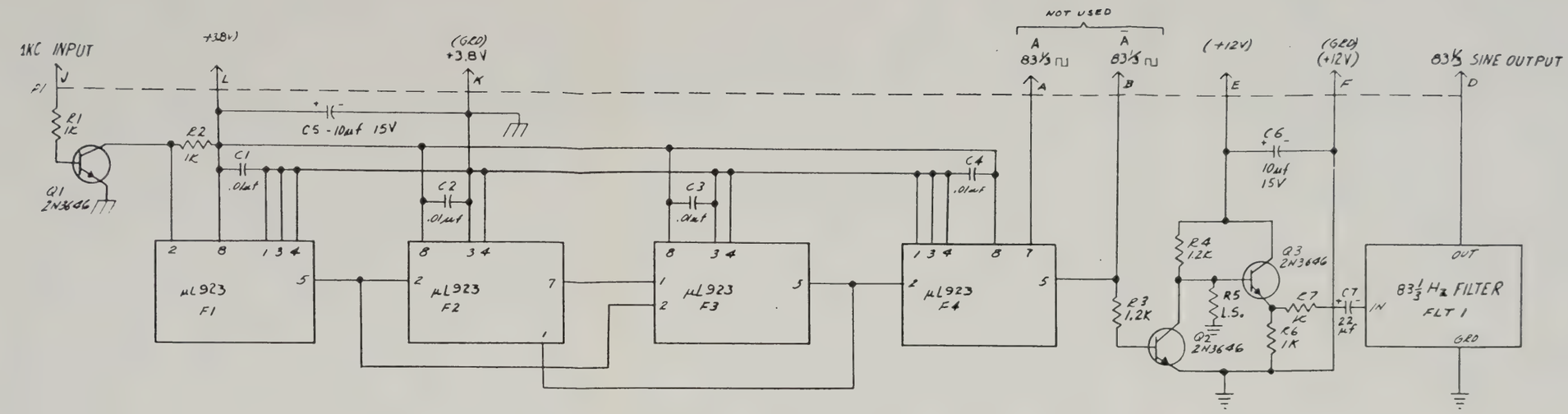
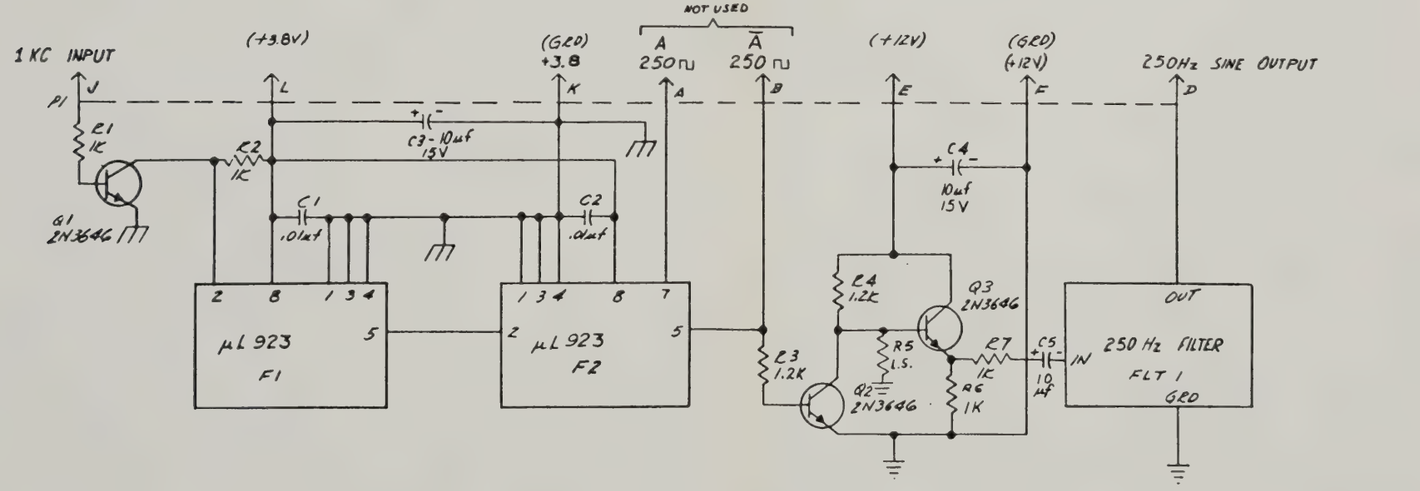


Figure 6-9. 83-1/3 Hz and 250 Hz Modulating Frequency Sources, Board A3



BOARD #3 - 83⅓ Hz



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BOARD #3 - 250 Hz

Figure 6-9. 83-1/3 Hz and 250 Hz Modulating Frequency Sources, Board A3

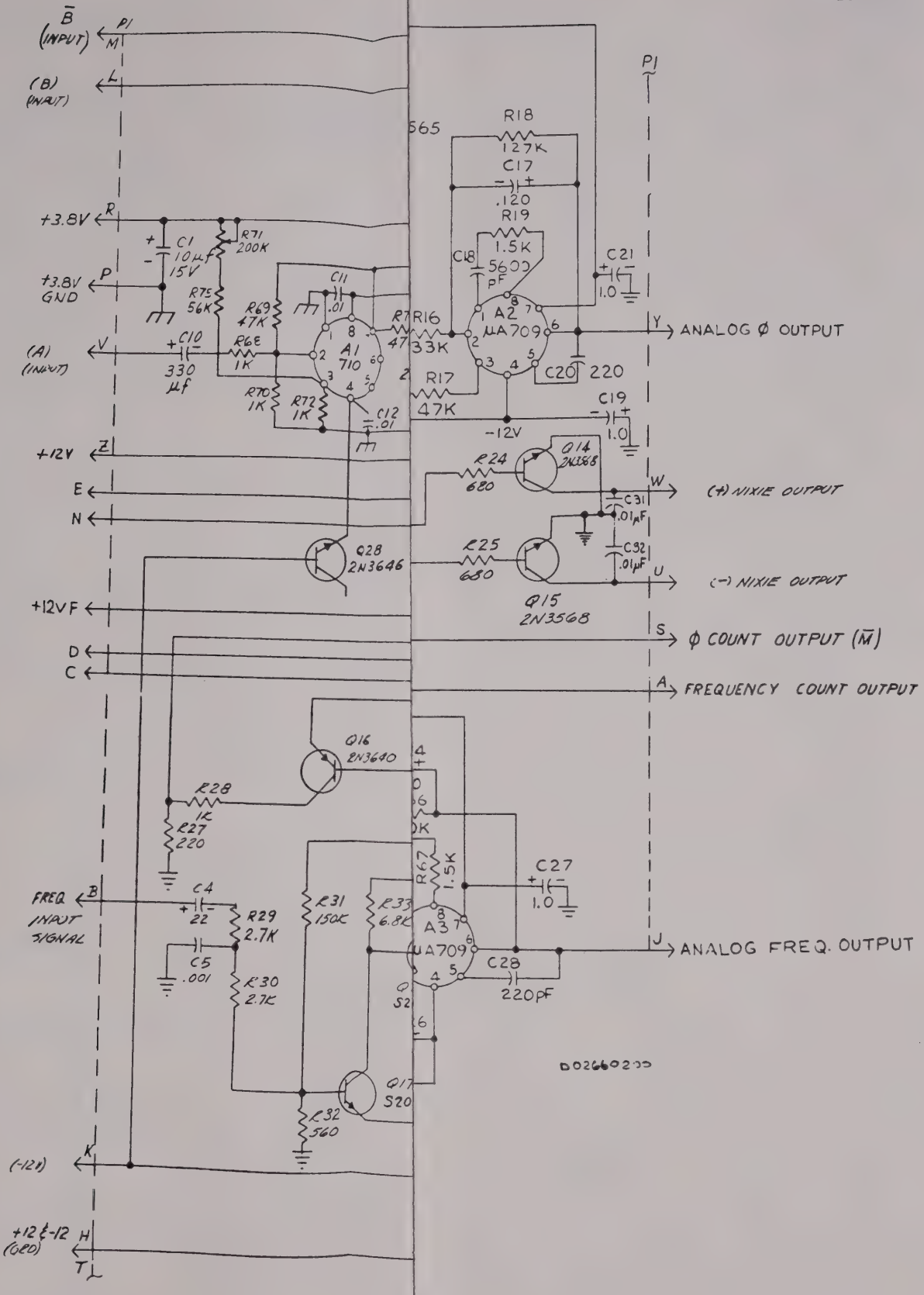


Figure 6-10. Sign Logic, Analog Phase and Analog f, Board A4

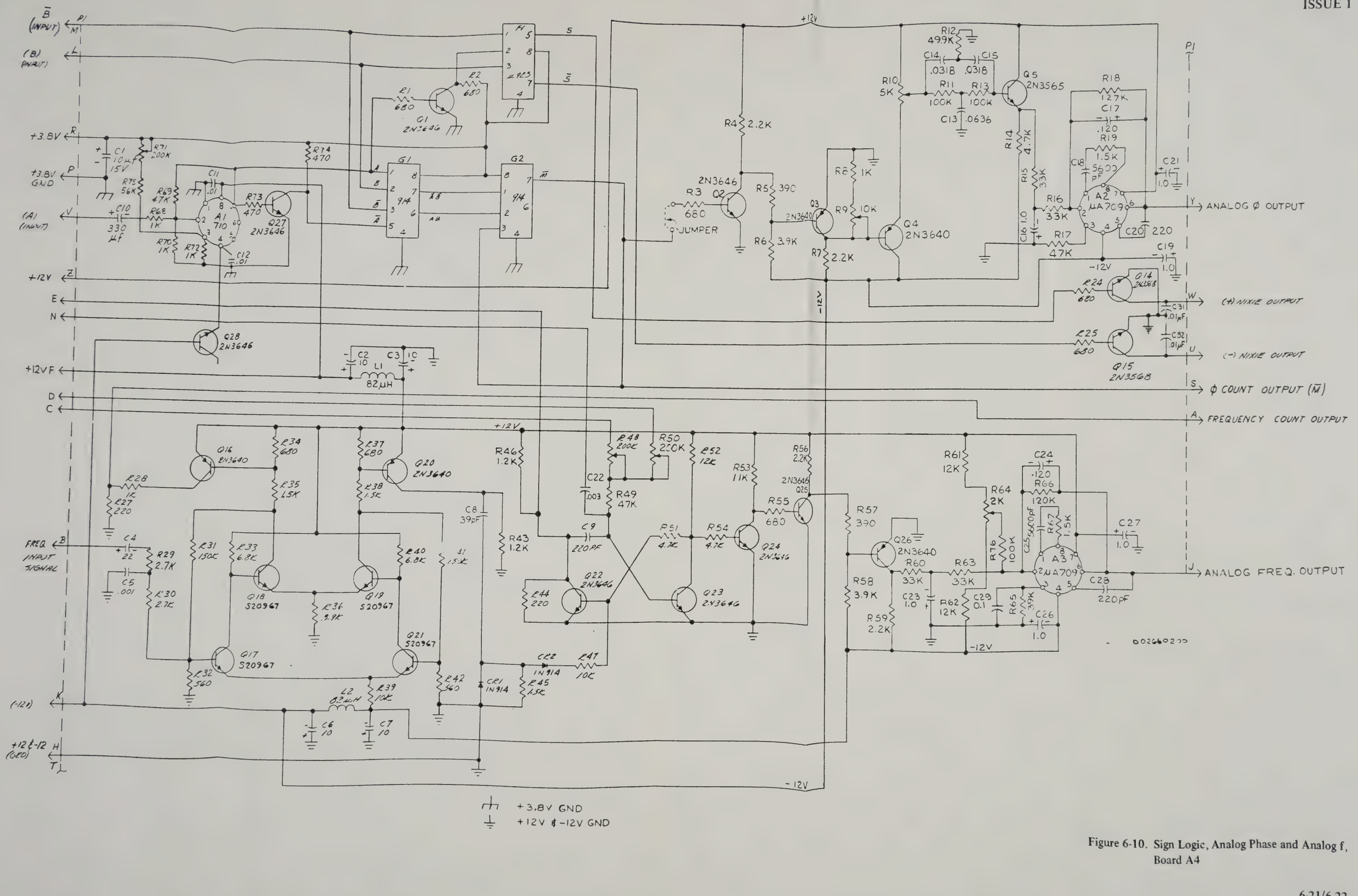


Figure 6-10. Sign Logic, Analog Phase and Analog f, Board A4

Control Setting	Waveform
Ø ADJ Max CCW Mod Freq 25 Scope 5 msec/cm 1V/cm	+1.3V
Ø ADJ Max CCW Mod Freq 83-1/3 Scope 2 msec/cm .5V/cm	+.9V
Ø ADJ Max CCW Mod Freq 250 Scope 5 msec/cm .5V/cm	3.0V
Pin A on J23 open Mod Freq 83-1/3	.4V
Pin A on J23 open	4.0V < .8 µsec
Pin A on J23 open	2.0V 1.5 µsec
Pin A on J23 open	7.0V 1 µsec

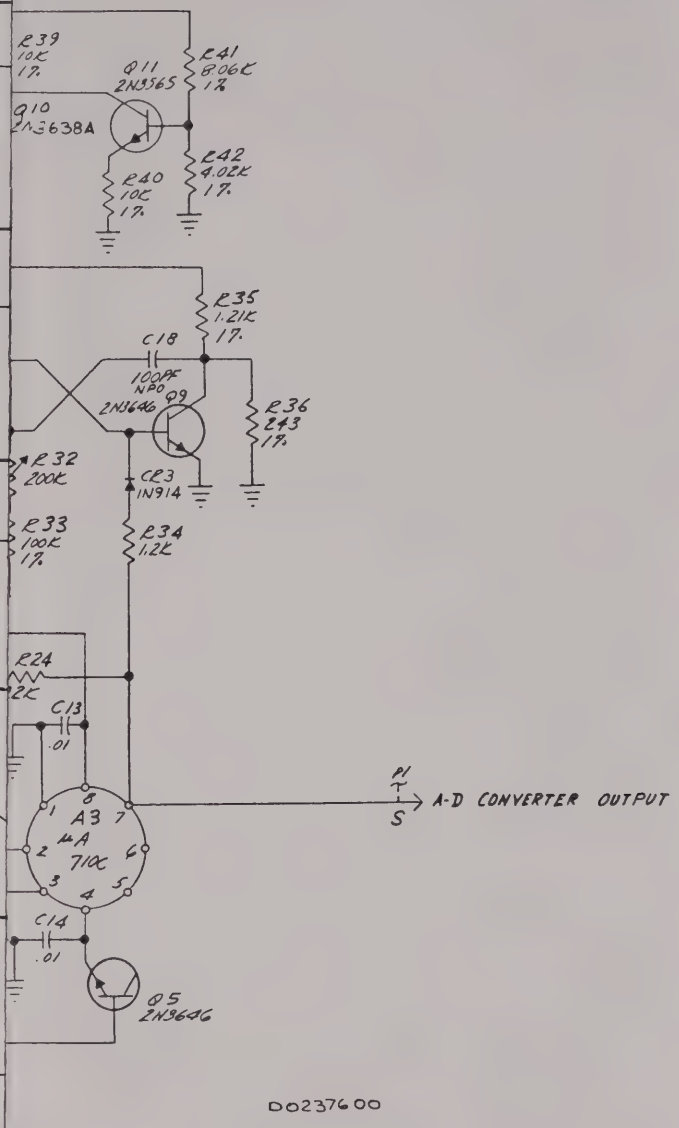
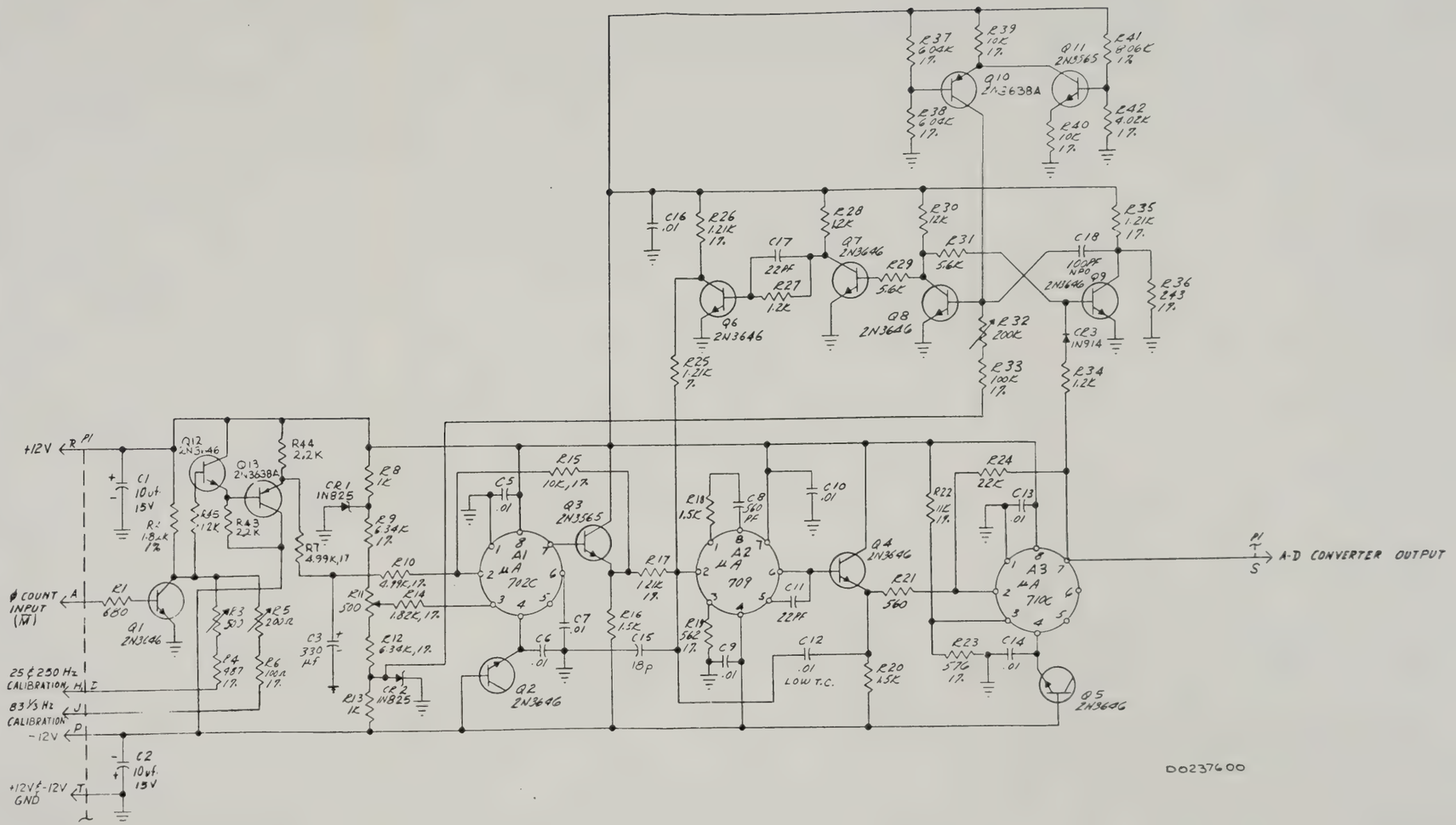


Figure 6-11. Analog to Digital Converter, Board A5

Control Setting	Waveform
Ø ADJ Max CCW Mod Freq 25 Scope 5 msec/cm 1V/cm	+1.3V a.
Ø ADJ Max CCW Mod Freq 83-1/3 Scope 2 msec/cm .5V/cm	+.9V b.
Ø ADJ Max CCW Mod Freq 250 Scope 5 msec/cm .5V/cm	3.0V c.
Pin A on J23 open Mod Freq 83-1/3	.4V d.
Pin A on J23 open	4.0V, < .8 µsec e.
Pin A on J23 open	2.0V, 1.5 µsec f.
Pin A on J23 open	7.0V, 1 µsec g.

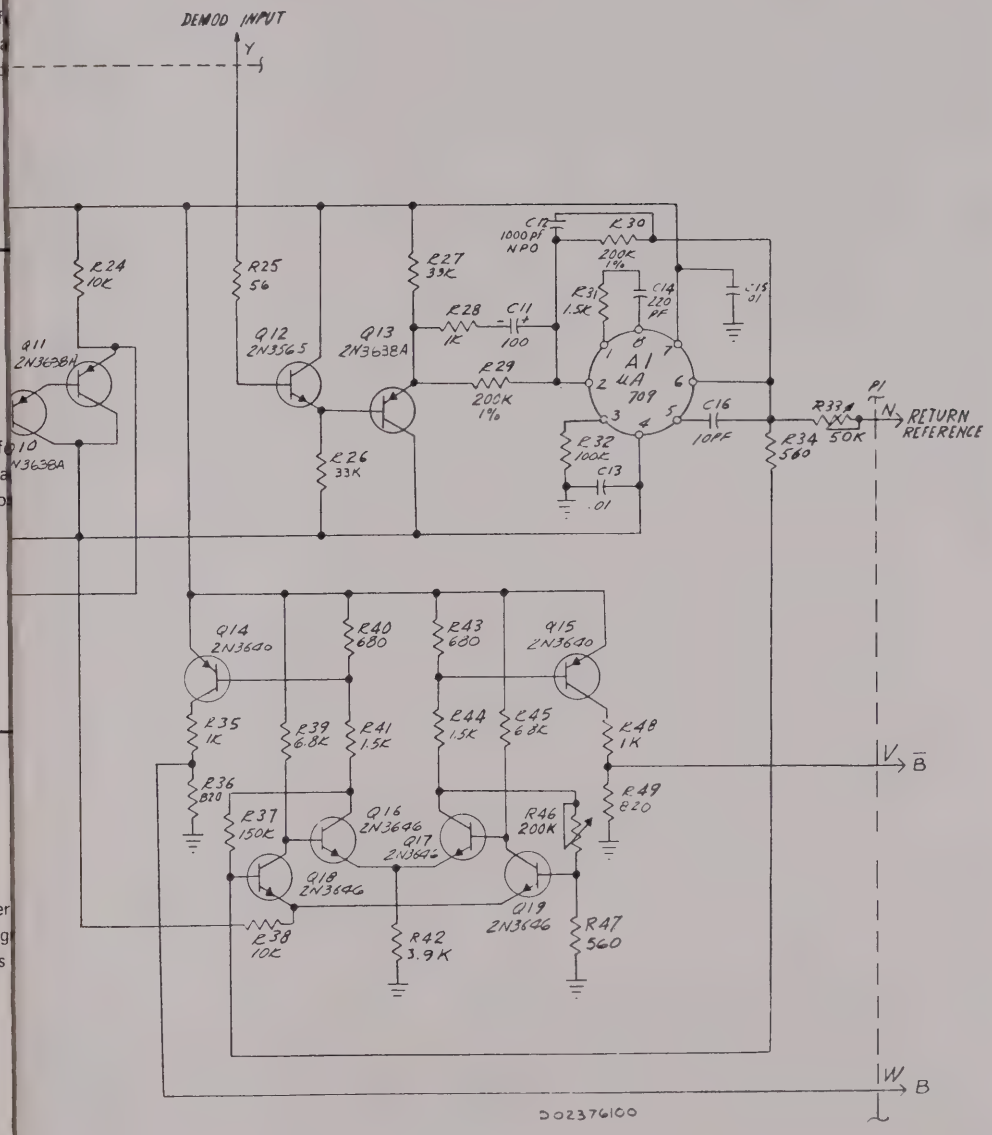


NOTE:
EFFECTIVE SER #'S 121 & UP

Figure 6-11. Analog to Digital Converter, Board A5

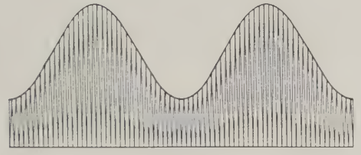
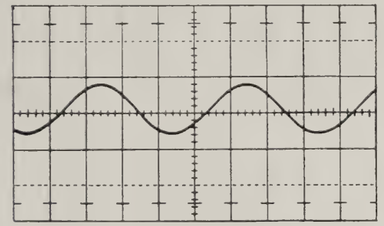
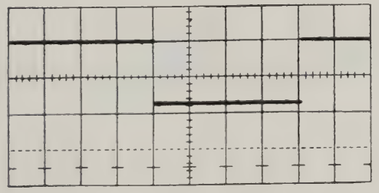
Test Point	Co
Pin Z, J21	Ref para step
Pin Y, J21	Ref para step
Pin W & V, J21	Refer paragr steps

8 TO +12). DUE TO CERTAIN CASES, 12 AND THE DIR- ERSED.



USED ON 09, 111 AND LIFIER IS WG.
Q25, Q26 & Q27 121 & 49, R12 ELIMINATED

Figure 6-12. Receiver AGC, Demodulator & Meter Amplifier, Board A6

Test Point	Control Setting	Waveform
Pin Z, J21	Refer to Section 7 paragraph 7.22 steps 1 through 6	 a.
Pin Y, J21	Refer to Section 7 paragraph 7.22 steps 1 through 6	 b. Vert. .05V/cm, Horiz. 5 msec/cm
Pin W & V, J21	Refer to Section 7 paragraph 7.22 steps 1 through 6	 c. Vert. .05V/cm, Horiz. 5 msec/cm

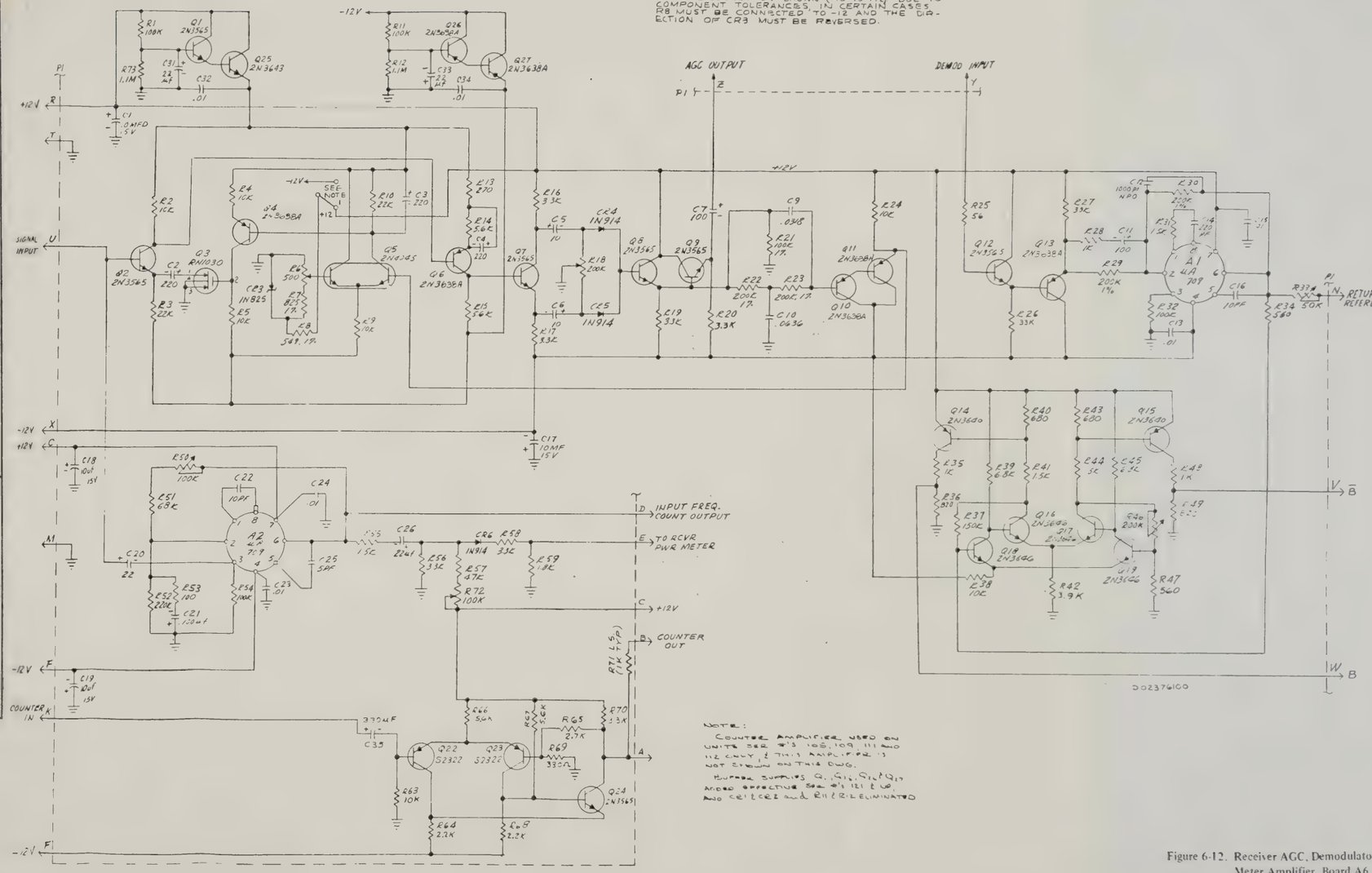
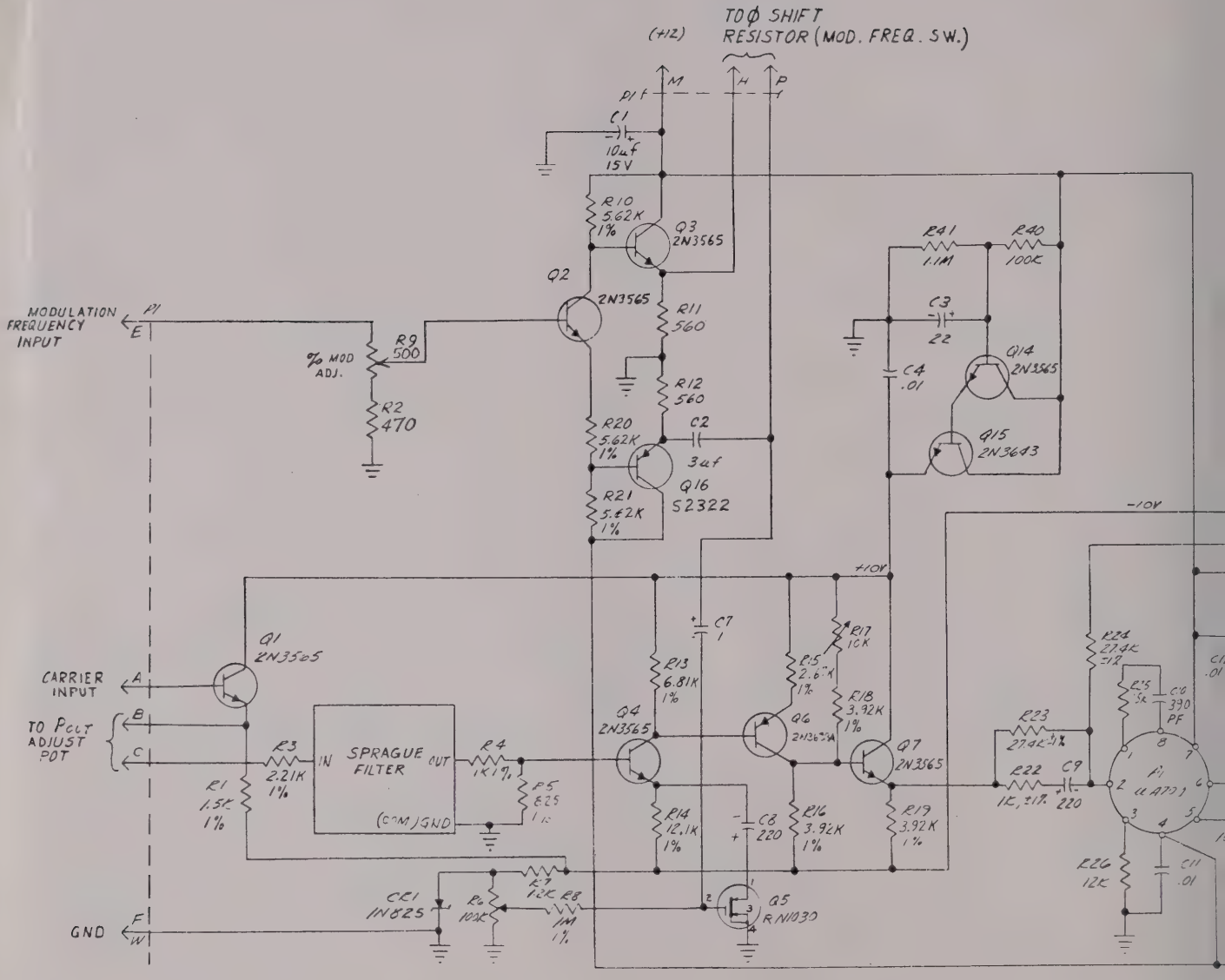
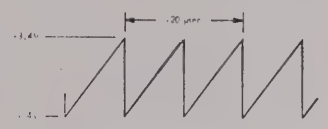
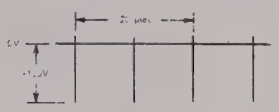
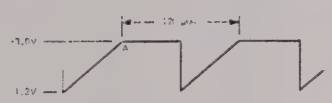
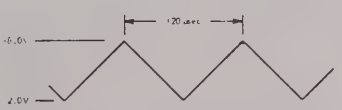
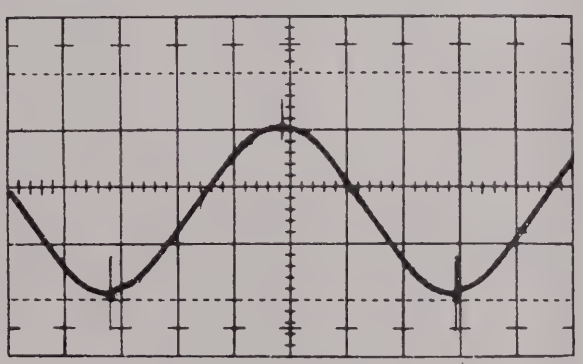

NOTES: 1. NORMAL CONNECTION SHOWN (CR8 TO +12) DUE TO COMPONENT TOLERANCES, IN CERTAIN CASES CR8 MUST BE CONNECTED TO -12 AND THE DIRECTION OF CR3 MUST BE REVERSED.
AGC OUTPUT
DEMOD INPUT
SIGNAL INPUT
INPUT FREQ. COUNT OUTPUT
TO RCVR PWR METER
COUNTER OUT
COUNTER IN
RETURN REFERENCE
+12V
-12V
NOTE:
COUNTER AMPLIFIER USED ON UNITS SER. #'S 105, 109, 111 AND 112 ONLY. THIS AMPLIFIER IS NOT SHOWN ON THIS DWG.
BUFFER SUPPLIES Q11, Q12, Q13, Q17 AND EFFECTIVE SER. #'S 121 & UP, AND CR12, R22 AND R11 ARE ELIMINATED
D02376100

Figure 6-12. Receiver AGC, Demodulator & Meter Amplifier, Board A6


TO Φ SHIFT RESISTOR (MOD. FREQ. SW.)
(HZ)
M
H
P
P1
C1 10uf 15V
R10 5.62K 1%
Q3 2N3565
Q2 2N3565
R11 560
R12 560
R20 5.62K 1%
C2 3uf
Q16 S2322
R21 5.62K 1%
MODULATION FREQUENCY INPUT
P1
E
% MOD ADJ.
R9 500
R2 470
R41 1.1M
R40 100K
C3 22
C4 .01
Q14 2N3565
Q15 2N3643
-10V
+10V
C7 1
R17 10K
R15 2.61K 1%
R18 3.92K 1%
Q6 2N3638A
Q7 2N3565
R13 6.81K 1%
Q4 2N3565
R14 12.1K 1%
C8 220
R16 3.92K 1%
R19 3.92K 1%
Q1 2N3565
CARRIER INPUT
A
TO Pout ADJUST POT
B
C
R3 2.21K 1%
R1 1.5K 1%
IN
SPRAGUE FILTER
OUT
(COM)GND
R4 1K 1%
R5 825 1%
R24 27.4K 1%
R25 5K
C10 390 PF
R23 27.4K 1%
R22 1K, 1%
C9 220
C11 .01
R26 12K
CR1 IN825
R6 10K
R7 12K
R8 1M 1%
Q5 RN1030
GND
F
W

Test Point	Control Setting	Waveform
Pin S, Q21	ΔHz - Man kHz SET - 8.33 kHz	 a.
Pin 2, F1	ΔHz - Man kHz SET - 8.33 kHz	 b.
Pin 5 & 7, F1	ΔHz - Man kHz SET - 8.33 kHz	c.
Emitter, Q13	ΔHz - Man kHz SET - 8.33 kHz	 d.
Emitter, Q31	ΔHz - Man kHz SET - 8.33 kHz	e.
Collector, Q14	ΔHz - Man kHz SET - 8.33 kHz	 f.
Pin A, J34	ΔHz - Man kHz SET - 8.33 kHz	 g. Vert. .5V/cm, Horiz. 20 μsec/cm

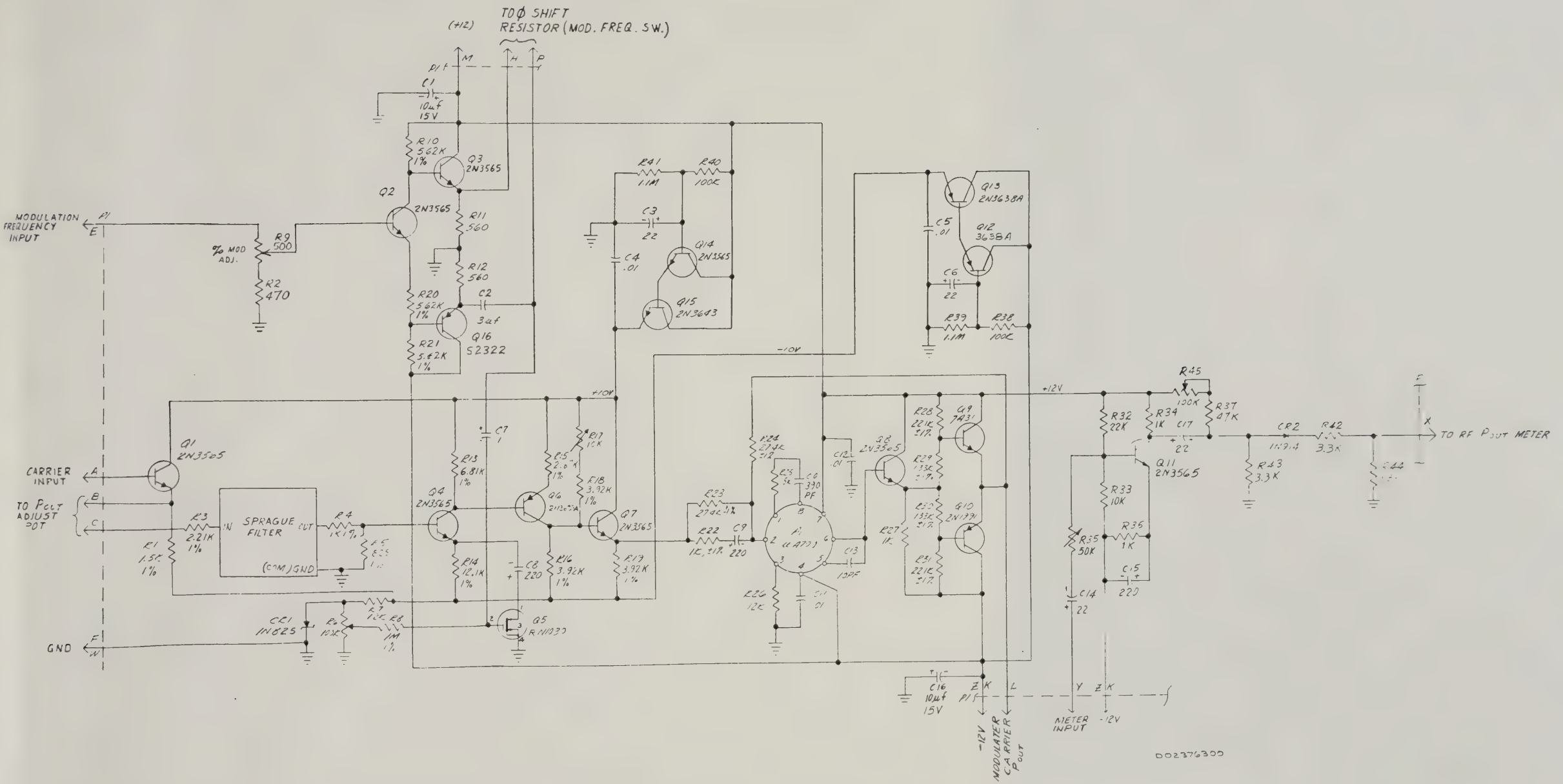
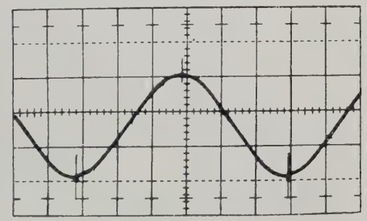


Figure 6-13. Output Amplifier & Meter Circuitry, Board A7

Test Point	Control Setting	Waveform
Pin S, Q21	ΔHz - Man kHz SET - 8.33 kHz	a.
Pin 2, F1	ΔHz - Man kHz SET - 8.33 kHz	b.
Pin 5 & 7, F1	ΔHz - Man kHz SET - 8.33 kHz	c.
Emitter, Q13	ΔHz - Man kHz SET - 8.33 kHz	d.
Emitter, Q31	ΔHz - Man kHz SET - 8.33 kHz	e.
Collector, Q14	ΔHz - Man kHz SET - 8.33 kHz	f.
Pin A, J34	ΔHz - Man kHz SET - 8.33 kHz	g.



Vert. .5V/cm, Horiz. 20 μsec/cm

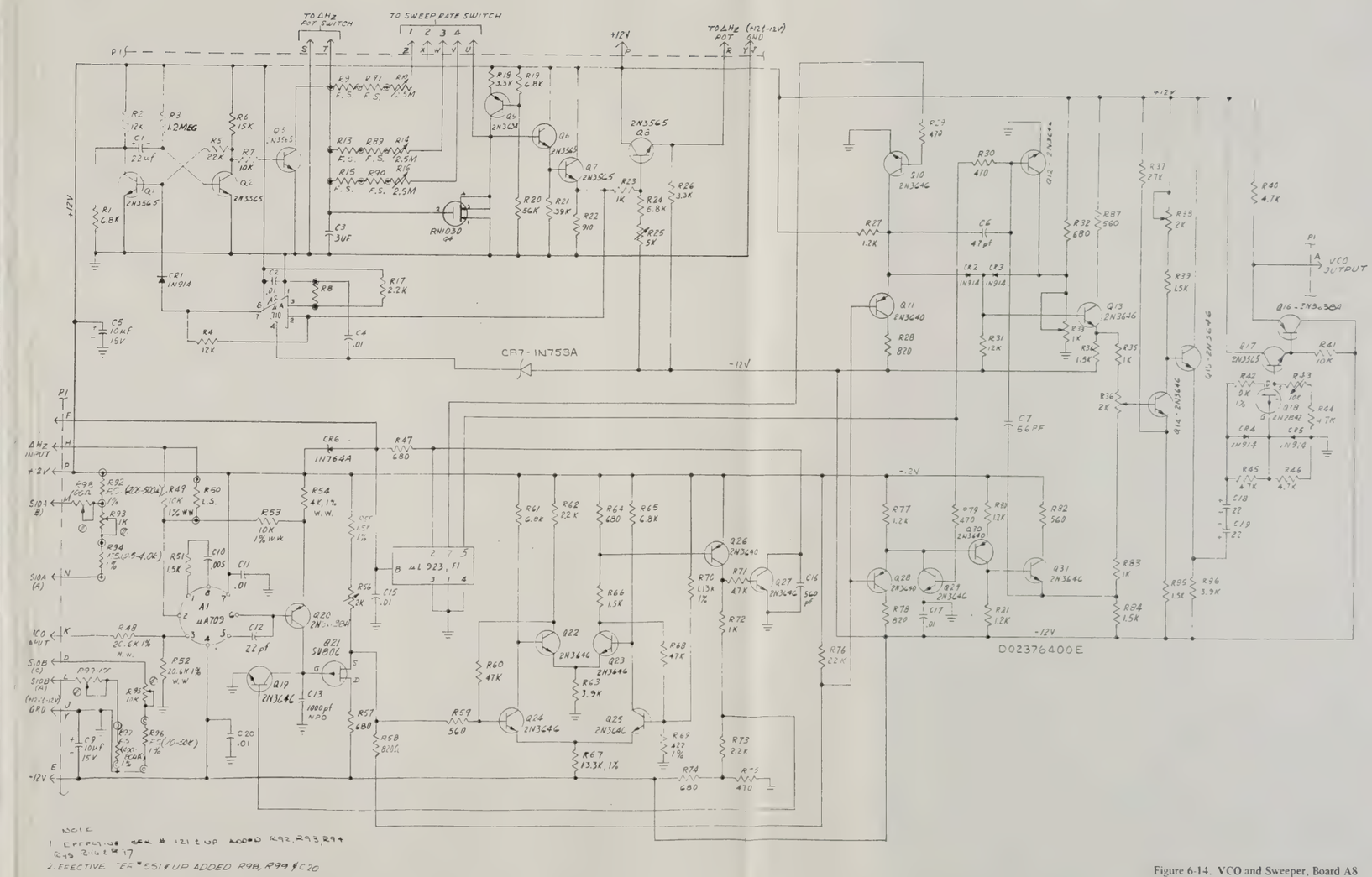


Figure 6-14. VCO and Sweeper, Board A8

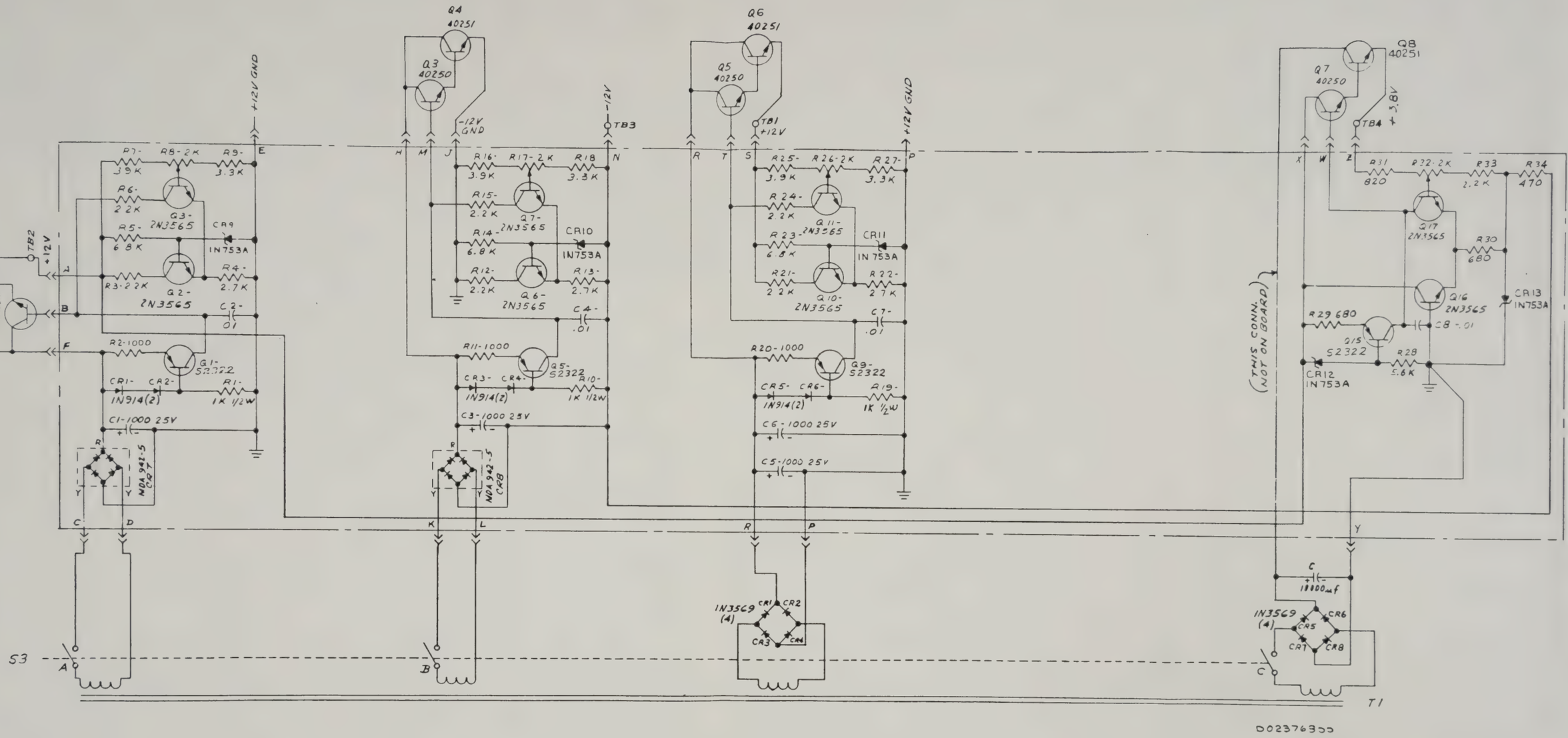


Figure 6-15. Low Voltage Power Supply, Board A9

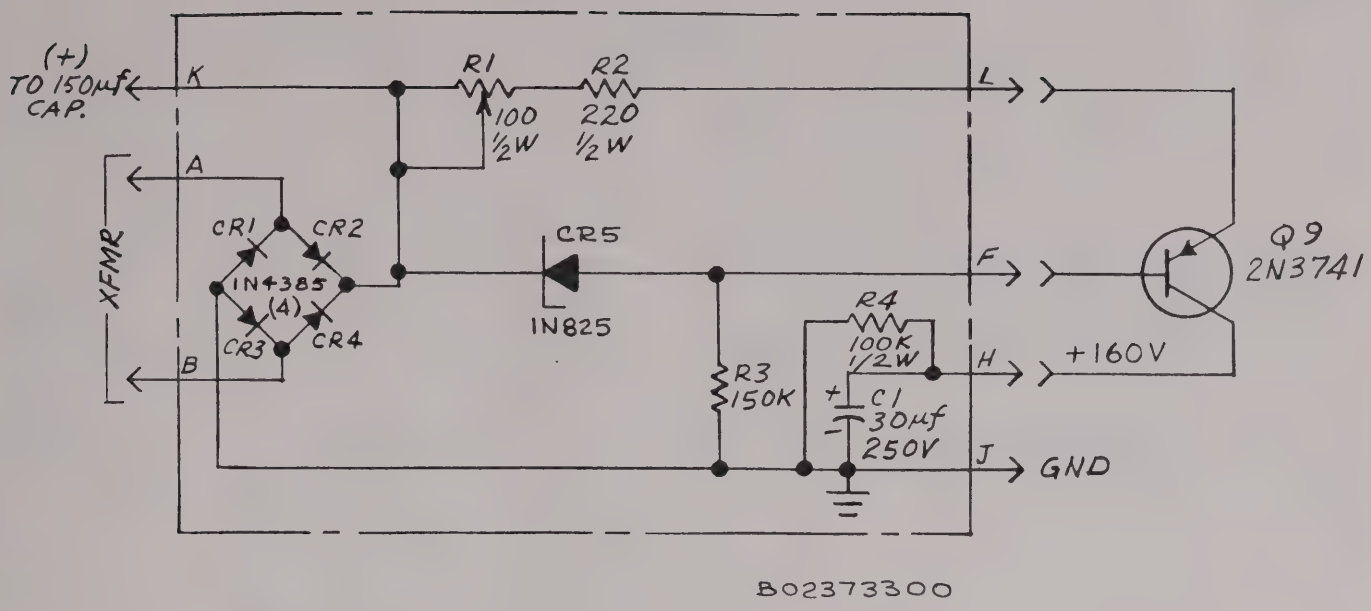


Figure 6-16. +155 Volt Supply, Board A10

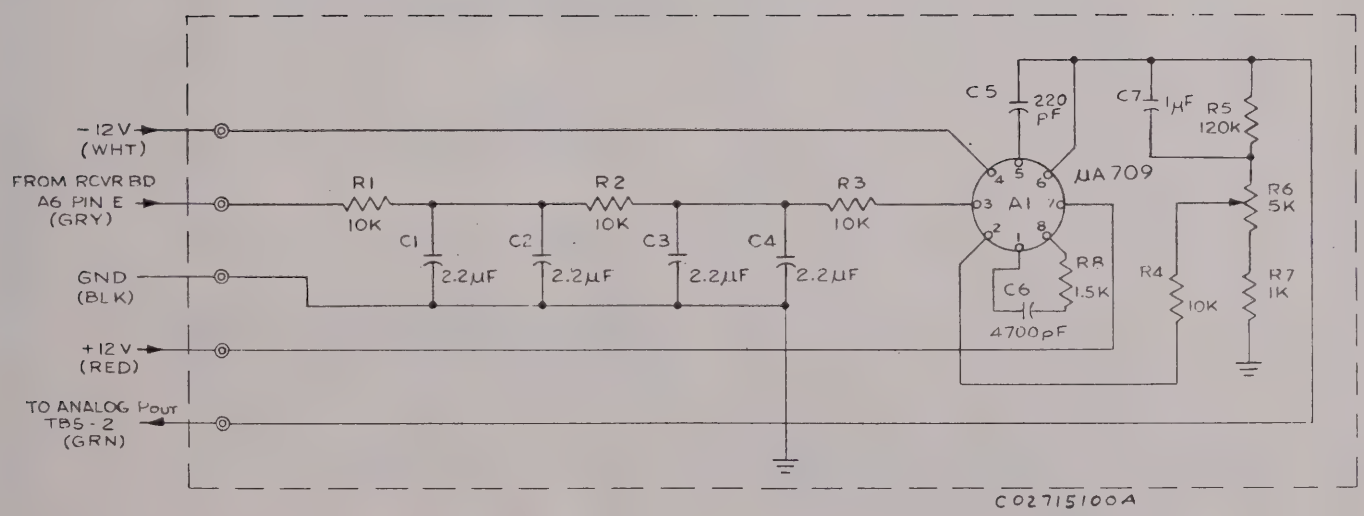


Figure 6-17. Analog Power Output Board – Schematic Diagram

SECTION 7
MAINTENANCE

Introduction

7.01 Section 7 gives information to enable the maintenance technician to check a 340B Test Set to see if it is operating within specifications. The tests require an oscilloscope (Tektronix 543 or equivalent), an oscillator (HP2000D or equivalent), a dc voltmeter (Simpson 260 multimeter or equivalent), and a frequency counter (HP5245L or equivalent).

Operational Test

7.02 **FRONT-PANEL READINGS AND CHECKS:** By following the procedure below, the operator can determine if the front-panel controls and indicators are operating properly.

STEP	PROCEDURE	NORMAL INDICATION
	NOTE: Make sure that the rear-panel 115V-230V ac line voltage selector switch is in the correct position for the ac supply to be used. Then plug the line cord into the ac supply at least one hour before the beginning of the check-out procedure to allow the ovens to reach a stable temperature.	
1	Set the rear-panel INT-EXT switch to the INT position.	
2	Set the NORM-RET REF switch to the NORM position.	
3	Turn the PWR switch to ON and allow the set to warm up at least 30 minutes.	The digital readouts light up, and the set becomes operative. If not check fuse (F1).
4	Connect the RF INPUT terminal to the RF OUTPUT terminal with a coaxial cable (RG-58C/U). This loop is to remain connected throughout the checkout procedure.	
5	Set Z IN and Z OUT controls to 600 ohms.	
6	Set P IN and P OUT controls to -10 dBm.	
7	Set CHECK-COUNTER-RCVR-XMTR switch to CHECK and adjust P OUT vernier control for a -5 dBm reading on the scale of both power meter (-15 dBm LEVEL).	
8	Set MOD FREQ switch to 250.	DELAY reads ±40,000 μsec ±1 digit, and FREQUENCY reads 0100.00 kHz ±1 digit.
9	Set the CHECK-COUNTER-RCVR-XMTR switch to RCVR or XMTR.	
10	Set MOD FREQ switch to 25.	DELAY reads ±4000.0 ±1 digit.

	PROCEDURE	NORMAL INDICATION
11	Adjust the kHz SET control for frequency 0.3-5 kHz and 5-110 kHz	Readings should be identical ±1 digit. DELAY readings between XMTR and RCVR positions should be within ±5 counts.
12	Check several frequency readings with selector switch in both RCVR and XMTR positions.	
13	Set the MOD FREQ control to 83-1/3 Hz and to 250 Hz and again check frequency readings over the 2.5-5 kHz and 5-110 kHz range in both RCVR and XMTR positions as in Steps 9 through 11.	Readings should be idential ±1 digit in both modulation frequency positions. DELAY readings should be the same and be stable to ±5 counts.
14	Adjust kHz SET to 10 kHz.	
15	Adjust P OUT vernier control for a XMTR meter reading of -10 dBm.	
16	Simultaneously switch the P OUT and the P IN controls to -10.0, and +10 dB.	Both meters continue to read -10 dBm ±1.0 dB.
17	Reset both controls to the -10 dB position. Vary the P OUT vernier control over its full range. **CAUTION:** The P OUT control should always be set to a low level before changing the Z OUT and Z IN controls to a lower impedance position.	Adjustment range should be 10 dB or greater.
18	Set the Z IN and Z OUT controls to the other impedance positions and after adjusting the P OUT vernier control to a meter scale reading of -10 dBm, follow the procedure of Steps 14 through 17 above.	Both meters continue to read -10 dBm ±1.0 dB. Adjustment range of the P OUT vernier control should be 10 dB or greater. **NOTE:** Maximum output power is 0 dBm in the 600 and 900 ohm impedance position.
19	Set the impedance controls to 75 ohms and set P OUT and P IN to -10 dB and adjust for a meter scale reading of -10 dB.	
20	Connect an oscilloscope to the RF OUTPUT and observe the waveshape.	A 50% amplitude-modulated envelope.
21	Set SWEEP RATE switch to 4 (sweeps per minute).	
22	Set MOD FREQ control to 25 Hz.	
23	Set FREQ RANGE switch to 0.3-5 kHz.	
24	Adjust the kHz SET control for a reading of 0.5 kHz.	

STEP	PROCEDURE	NORMAL INDICATION
25	Set CHECK-COUNTER-RCVR-XMTR switch to RCVR.	
26	Adjust ΔHz control to 50% setting.	The FREQUENCY display linearly changes count from the initial setting of 0.5 kHz to approximately 3.0 kHz. (After the ΔHz control is turned on it may be necessary to readjust the 0.5 kHz point with the kHz SET control. This can be done during the 10-second blank time of the sweep.)
27	Set FREQ RANGE switch to the 5-110 kHz position. Leave the Hz control at 50%. During the 10-seconds blank time, adjust the kHz SET control for 10 kHz.	The FREQUENCY display counts linearly from the initial setting of 10 kHz to approximately 60 kHz.
28	With the MOD FREQ control set to 25 (Hz) and the SWEEP RATE switch set to the OFF position, turn the ∅ ADJ control through its range.	The DELAY reading should be adjustable from +4000 μsec to -10,000 μsec, ±1000 μsec.

Envelope Delay Response

7.03 The following procedure checks the envelope delay response.

STEP	PROCEDURE	NORMAL INDICATION
1	Set Z IN and Z OUT to 75.	
2	Set P IN and P OUT switches to -10 and adjust vernier P OUT control for a meter reading of 0 dB (power level of -10 dBm.)	
3	Set CHECK-COUNTER-RCVR-XMTR switch to RCVR.	
4	Set MOD FREQ switch to 25 (Hz).	
5	Set carrier frequency Range switch to 5-110 kHz.	
6	Set SWEEP RATE switch to 0.5 (sweeps per minute).	
7	Set SWEEP ΔHz control to 100% and adjust kHz SET control so that sweep starts at 10 ±1 kHz. **NOTE:** The sweep range covered, as read on the FREQUENCY readout, will then be from	

STEP	PROCEDURE	NORMAL INDICATION
	a minimum range of 10 kHz to 110 kHz (i.e., 100 kHz).	
8	During the sweeper blank time (the 10-second period of minimum frequency) adjust the Ø ADJ control for a DELAY reading of +1000 ±1 μsec. As the frequency is swept over the range by the sweeper, note the maximum positive and negative deviations of the DELAY reading from the reference (1000 μsec) setting.	Maximum deviation does not exceed 22 μsec with a modulation frequency of 25 Hz.
9	Set the MOD FREQ control to 83-1/3 and follow procedure of Steps 1 through 8 noting the maximum DELAY reading deviations from the reference.	Maximum deviation does not exceed 6 μsec for a modulation frequency of 83-1/3 Hz.
10	Set the MOD FREQ control to 250 and follow the procedure of Steps 1 through 8 noting the maximum DELAY reading deviation.	Maximum deviation does not exceed 2.2 μsec for a modulation frequency of 250 Hz.
11	Set the SWEEP RATE switch to the OFF position.	
12	Set MOD FREQ to 25 Hz, the CARRIER FREQUENCY RANGE switch to 0.3-5 kHz, and the Z IN/Z OUT switch to 600 ohms.	
13	Adjust P OUT vernier control for a -5 dBm reading on the scale of both power meters (-15 dBm LEVEL).	
14	Set 0 ADJ for a DELAY reading of +1000 ±3 μsec.	
15	Adjust the kHz SET control over the 0.3-5 kHz band and note any DELAY reading deviations from the reference (+1000 μsec) setting. **NOTE:** If increased accuracy is desired, loop the instrument back to itself.	Over the frequency range of 0.6-5.0 kHz the maximum deviation is not more than 10 μsec. Figure 8 illustrates a typical curve of envelope delay versus frequency range of 0.3-0.6 kHz.
16	Set Z IN/Z OUT to either the 600/600 ohm or the 900/900 ohm position.	
17	Set P OUT = P IN = 15 dBm.	
18	Set the MOD FREQ switch to either the 25 Hz or the 83-1/3 Hz position.	
19	Adjust the kHz SET control and plot an envelope delay versus frequency curve for the frequency range, the Z IN/Z OUT impedance, and the MOD FREQ of interest.	

STEP	PROCEDURE	NORMAL INDICATION
	NOTE: At carrier frequencies which are harmonically related to the modulation frequency large fluctuations of envelope delay readings may occur. The lower the carrier frequency, the larger the fluctuations will be. This condition has a very restricted bandwidth, so that a very slight adjustment of the carrier frequency (1-3 Hz) will eliminate the condition. At carrier frequencies above 600 Hz the bandwidth at which this may occur is less than ±1 Hz.	
20	Set MOD FREQ to 83-1/3 Hz and manually adjust the kHz SET control from 0.6-5 kHz.	Over the frequency range of 0.6-5 kHz the maximum deviation does not exceed 5 μsec.
21	Set MOD FREQ to 250. Manually adjust the kHz SET control from 2.5-5 kHz.	Over the frequency range of 2.5-5 kHz maximum deviation does not exceed 1.0 μsec.
22	At each selected carrier reference frequency, adjust 0 ADJ control for a DELAY μsec indication of +100.00 ±0.3 μsec.	

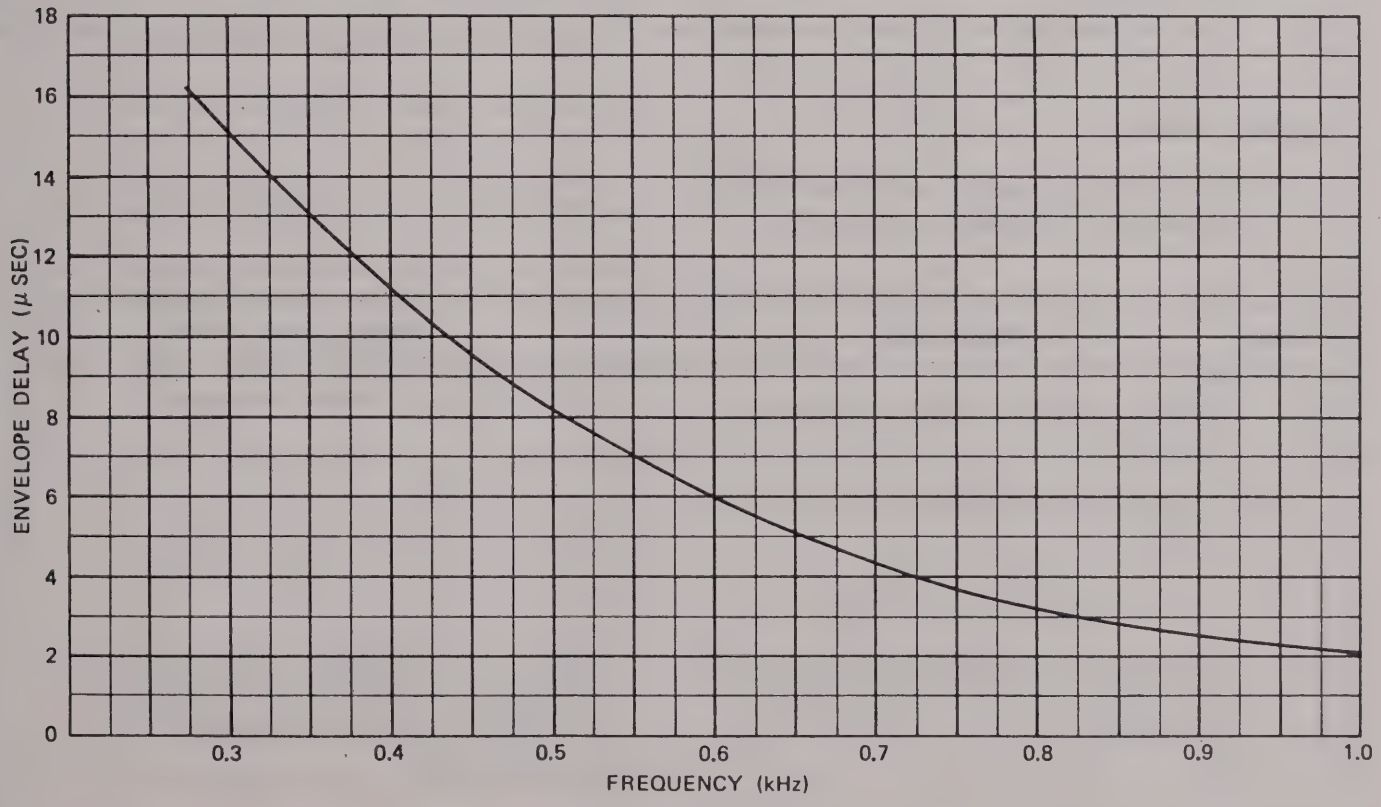


Figure 7-1. Typical Envelope Delay Versus Frequency Curve

Counter Check

7.04 The following procedure checks the accuracy of the FREQUENCY readout.

STEP	PROCEDURE	NORMAL INDICATION
1	Set the front-panel controls as described in Paragraph 6.02.	
2	Connect an audio oscillator to the COUNTER INPUT jack, and set the audio oscillator output to −10 dBm (600 ohms ref.).	
3	Connect a frequency counter across the audio oscillator output.	
4	Turn the CHECK-COUNTER-RCVR-XMTR switch to the COUNTER position.	
5	Read the frequency of the audio oscillator on both the Test Set FREQUENCY readout and on the frequency counter.	The two counters agree within 4 Hz.
6	Check at several other frequencies between 10 Hz and 1 MHz.	The two counters agree within 4 Hz.

Stability Check

7.05 The following procedure checks the stability of the delay and frequency measuring circuits.

STEP	PROCEDURE	NORMAL INDICATION
1	Set the front-panel controls as described in Paragraph 6.02.	
2	Set CHECK-COUNTER-RCVR-XMTR switch to RCVR.	
	Adjust kHz SET control to 50 kHz.	
	Set MOD FREQ switch to the 25 position, and set ∅ ADJ control for a DELAY reading of +1000 μsec.	Over a 15-second period, the DELAY reading does not change more than ±3 μsec and the FREQUENCY reading does not change more than ±1 digit (±10 Hz).

7.06 **OPERATION WITH EXTERNAL OSCILLATOR:** Connect a variable oscillator of good stability to the BNC EXT. OSC. INPUT connector on the rear panel and set the switch above the connector to EXT. All front-panel readings should be the same as in Steps 9 through 13 of Paragraph 7.02 for the procedure given there, except that the external oscillator should be varied instead of the kHz SET control.

7.07 **ANALOG (∅) OUTPUT CHECK:** At the ANALOG (∅) output terminal a dc voltage (referenced to GND terminal) should be observed that is proportional to the DELAY readout. The proportionality constant is approximately +10 volts +20,000 μsec for 25 Hz modulation; +10 volts ±6,000 μsec for 83-1/3 Hz modulation; and +10 volts ±2000.0 μsec for 250 Hz modulation.

7.08 **ANALOG (f) OUTPUT CHECK:** At the ANALOG (f) terminal a dc voltage should be observed that is proportional to the frequency reading. The proportionality constant is approximately +10 volts 110.000 kHz or +10 volts 5.000 kHz, depending upon the position of the FREQUENCY kHz switch.

Analog Power Output

7.09 To ensure that the Analog Output circuit is operating properly, perform the following test:

STEP	PROCEDURE	NORMAL INDICATION
	NOTE: Make sure that the rear-panel 115V-230V ac line voltage selector is in the correct position for the ac supply to be used. Then plug the line cord into the ac supply at least one hour before the beginning of the check-out procedure to allow the ovens to reach a stable temperature.	
1	Set the Z IN and Z OUT controls to 600 ohms.	
2	Set the FREQUENCY Switch to the 10.000 kHz position.	
3	Set the P IN Switch to the 0 dBm position.	
4	Connect a HP400L, or equivalent, to the power output jack (J3).	
5	Connect the RF INPUT Terminal to the RF OUTPUT Terminal with a coaxial cable (RG-58C/U). **NOTE:** This loop is to remain connected throughout the checkout procedure.	
6	Connect the HP412A, or equivalent, to the analog power output (TB5-2) located on the rear panel.	
7	Set the P OUT Switch to the -10 dBm position. Use the vernier control to obtain -10 dBm on the HP400L.	
8	Remove the top dust cover from the 340B.	
9	At the Analog Power Output board, adjust the 5K potentiometer (R6) for a +3.0 Vdc analog output.	

STEP	PROCEDURE	NORMAL INDICATION
10	Adjust the P OUT and the vernier control for a meter reading of 0 dBm on the HP412A.	The analog output should now be approximately +10 Vdc.
11	Adjust the P OUT and vernier control for a meter reading of -20 dBm on the HP 412A.	The analog output should now be approximately +1.0 Vdc.

Alignment Procedure

7.10 The following test equipment, or equivalent, is required to perform the alignment of the 340B.

Oscilloscope	Tektronic 543
Oscillator	HP 200CD
DC VTVM	HP 412A
AC VTVM	HP 400L
Multimeter	Simpson 260
Frequency Counter	HP 5254L

7.11 **POWER SUPPLIES, BOARDS A9 AND A10.** Voltage readings and adjustments on the power supply boards are made in the following manner:

NOTE: Be sure to discharge the filter capacitor (C1) on board A10 before removing the board. Turn off power before discharging the capacitor.

Step 1
Connect the 340B to a 110V ±15 volt ac source.

NOTE: Use a variable transformer, if necessary, to obtain the ac supply voltage.

Step 2
With the front panel PWR Switch in the OFF position, the voltage on connector J36 between pins S and P (GRD), should be +12 Vdc ±100mV.

NOTE: Voltage adjustment control is R26 on board A9.

Step 3
With front panel PWR Switch in the ON position, check the following voltages on connector J36.

a. Between pins A and E (GRD) +12 Vdc ±100 mV. Adjustment control is R8 on board A9.

b. Between pins N and J (GRD –12 Vdc, ±100 mV. Adjustment control is R17 on board A9.

c. Between pins Z and Y (GRD) +3.6 Vdc, ±100 mV. Adjustment control is R32 on board A9.

Step 4
With the front panel PWR Switch in the ON position; at connector J8, between pins H and J (GRD) read +160 +2-5 Vdc. Adjustment control is R1 on board A10.

7.12 **1 MHz Oscillator.** Connect Oscilloscope to connector J22 pins 7 and 9 (GND.). Output should be a sine wave, 4V p-p minimum, with less than 5% distortion. After the Test Set has been connected to the ac supply and warmed up for at least 1-1/2 hours, connect the Frequency Counter to pins 7 and 8. The frequency should be one megahertz ±0.1 Hz. If necessary, adjust the oscillator to this frequency. The initial adjustment should be made through the top of the oscillator can. Fine adjustment to the frequency may be made with the Front panel SYNC control.

7.13 **Display Logic Boards A1-1 to A1-6.** Place the function switch in the CHECK position. The DELAY should read 40,000 microseconds ±1 digit, and the FREQUENCY 0100.00 kHz ±1 digit. If these indications are obtained, the Display Logic boards are functioning properly. If one or more digits read incorrectly, consult Troubleshooting Procedure.

7.14 **Divider and Control Logic, Board A2.** There are no adjustments to be made on this board. If the Display Logic shows the correct count with the function switch in the CHECK position, this board is operating properly. If not, see Troubleshooting Procedure.

7.15 **VCO and Sweeper, Board A8.** Waveform Adjustments are made as follows:

Step 1
Set function switch to XMTR, FREQUENCY kHz switch to 5-110 kHz, and SWEEP RATE Switch to the OFF Position.

Step 2
Adjust kHz SET control for a FREQUENCY reading of 8.33 kHz.

Step 3
Connect the oscilloscope to pin S (source) of Q21. (See Figure 6-14 for base pin diagrams.)

Step 4
Adjust R56 for best slope linearity. See waveform and Timing, Figure 6-19.

Step 5
Connect the oscilloscope to the emitter of Q13.

Step 6
Adjust R33 to obtain the waveform of Figure 6-14 with no discontinuity at point A.

Step 7
Connect a scope probe to the collector of Q14. Adjust the kHz pot for a carrier frequency of 8.6 kHz. Adjust R36 and R33 alternately to obtain a perfect triangular waveform. See Figure 6-14.

Step 8
Monitor the VCO output J34 pin A with a scope. Adjust R37 and R43 until a clean symmetrical sinewave is obtained.

NOTE: Small spikes at maximum and minimum points on waveform are removed by the input filter on board A-7.

7.16 Frequency range adjustments are made as follows:

STEP	PROCEDURE	NORMAL INDICATION
1	Set FREQUENCY kHz switch to 5-110 kHz.	
2	Adjust the kHz SET control to the full clockwise position.	FREQUENCY display should read 117 ±5 kHz.
3	Adjust the kHz SET control to the full counter-clockwise position.	FREQUENCY display should read 3.8 ±0.5 kHz.
	NOTE: These limits have been factory set with fixed calibrating resistors in parallel with R92 and R97.	
4	Set FREQUENCY kHz switch to 0.3-5 kHz.	
5	Turn kHz SET control full counterclockwise.	Frequency should read 6.4 ±0.6 kHz.
	NOTE: If necessary adjust R95. R93 and R95 are interacting controls. It may be necessary to alternately readjust them until the proper range limits are obtained.	
6	Turn kHz SET control full counterclockwise.	Frequency should read .085 ±.015 kHz.

7.17 Sweep width adjustments are made as follows:

STEP	PROCEDURE	NORMAL INDICATION
1	Set FREQUENCY kHz switch to 0.3-5 kHz.	
2	Rotate SWEEP ΔHz to 100%.	

STEP	PROCEDURE	NORMAL INDICATION
3	Set SWEEP RATE switch to 4.	
4	Turn kHz SET control full counterclockwise and observe minimum frequency during the 10 second hold period of the sweep.	A minimum frequency of 0.10 kHz ±1 digit should be observed. NOTE: It may be necessary to adjust R25 to obtain this frequency.
5	Set FREQUENCY kHz switch to 5-110 kHz.	
6	Set the lower limit to 10.00 kHz ±1 digit by adjusting the kHz SET control and observe the upper limit of the sweep.	The upper limit should be 116 ±6. The sweep should return to 10.00 ±1 digit. NOTE: These limits are factory set with a resistor in parallel with R8.

7.18 Sweep Time Adjust

Step 1
Set Δ Hz SWEEP control to the 25K position and the SWEEP RATE switch to 4.

Step 2
Connect an oscilloscope to J35-H of the Δ Hz RAMP.

Step 3
Adjust R16 on board A8 to obtain a sweep ramp of 15 ±1.5 seconds duration, if necessary.

Step 4
Set SWEEP RATE switch to 2.

Step 5
Adjust R14 to obtain a sweep ramp 20 ±3 seconds, if necessary.

Step 6
Set SWEEP RATE switch to 0.5.

Step 7
Adjust R10 to obtain a sweep ramp of 120 ±5 seconds duration, if necessary.

7.19 **Output Amplifier and Meter Circuitry, Board A7.**
P OUT Meter adjustments are made in the following manner:

STEP	PROCEDURE	NORMAL INDICATION
1	Connect a short coax test lead between RF OUTPUT and RF INPUT. NOTE: This OUTPUT-INPUT loop to remain connected throughout adjustment procedure.	
2	Remove board A3-250 from J27.	
3	Set Z IN and Z OUT switches to 600.	
4	Set P IN switch to 0 and P OUT switch to -10.	
5	Turn P OUT variable control full counterclockwise.	

STEP	PROCEDURE	NORMAL INDICATION
6	Set MOD FREQ switch to 250 and CHECK-COUNTER-RCVR-XMTR switch to XMTR.	
7	Turn kHz SET control to 10 kHz.	
8	Set XMTR-RET REF-LOOP/E-E RCVR switch to LOOP/E-E RCVR position and INT-EXT switch to EXT (no input connected to EXT OSC jack).	
9	Set oscilloscope to dc, 5 mV/cm sensitivity and adjust trace to center line of vertical scale.	
10	Connect oscilloscope to RF OUTPUT and adjust R17 (board A7) for a zero-volt ±5 mV dc level.	
11	Set INT-EXT switch (on rear panel) to INT.	
12	Connect ac VTVM to RF OUTPUT.	
13	Set P OUT switch to 0.	
14	Switch Z IN and Z OUT switches to 900.	
15	Turn P OUT control full clockwise.	Ac VTVM should read 2.0 ±1.0V rms.
16	Turn P OUT control full counterclockwise.	**NOTE:** Adjust R6. It may be necessary to obtain an output voltage within this range.
17	Set Z IN and Z OUT switches to 600.	
18	Adjust P OUT control for a reading of -10 dBm on the ac VTVM.	
19	Adjust R35 (board A7) for a -10 dBm reading on the Output DBM meter (M2).	
20	Adjust output level to) dBm with the P OUT control.	Output DBM meter and ac VTVM should track within ±0.25 dB. **NOTE:** It may be necessary to adjust R45 and R35 to obtain best linearity and accuracy.
21	Set output to -10 dBm with P OUT control.	
22	Turn P OUT switch to +10 position.	Output meter should remain constant within ±0.5 dB.

7.20 **50% Modulation Adjustment.** 50% modulation adjustments are made in the following manner:

STEP	PROCEDURE	NORMAL INDICATION
1	Replace board A3-250 in J27.	
2	Set Z OUT and Z IN switches to 600.	
3	Turn MOD FREQ switch to 25.	
4	Set P OUT switch to 0 and adjust P OUT control for 0 dBm.	
5	Adjust lab set resistor R51 (board A2) to obtain a 50 ±5% modulation envelope.	Oscilloscope display should show a 50% modulation waveform. (See Figure 6-8.)
6	Turn MOD FREQ switch to 83-1/3 and 250.	
	NOTE: Output waveform should be 50% modulated in each case. It may be necessary to adjust R9 to bring the modulation within ±5% of 50% modulation for the three frequencies. Basic percentage of modulation adjustment is accomplished with lab set resistor R51 (board A2) for 25 Hz and R5 (board A3) for 83-1/3 and 250 Hz.	
7	Turn kHz SET control to 10 kHz.	
8	Set Z OUT and Z IN to 75 and 135.	Envelope should be visibly free of distortion.
	NOTE: For each impedance vary the output power for -20 dBm to +10 dBm while observing the output envelope on the oscilloscope. Perform check for 25 Hz, 83-1/3 Hz and 250 Hz modulation modulating frequencies.	
9	Perform the same test as in Step 8 for 600 ohms and 900 ohms but vary the power from -20 dBm to 0 dBm.	

7.21 **Power Output Flatness Response.** Flatness response measurements are made in the following manner:

STEP	PROCEDURE	NORMAL INDICATION
1	Set Z OUT and Z IN switches to 600.	
2	Adjust P OUT to -10 dBm.	
3	Observe power output on ac VTVM as frequency is varied over the range 0.3-5 kHz and 5-110 kHz.	Variation in power output should be within the following limits: 0.3-5 kHz ±0.15 dB 5-60 kHz ±0.5 dB 5-110 kHz ±0.75 dB

7.22 **Receiver, AGC, Demodulator and Meter Amplifier, Board A6.** P IN Meter Adjustments are made as follows:

STEP	PROCEDURE	NORMAL INDICATION
1	Connect RF OUTPUT to RF INPUT with a short coax cable test lead. **NOTE:** This loop connection to remain throughout adjustment procedure.	
2	Set Z IN and Z OUT switches to 600.	
3	Set P IN and P OUT switches to the -10 dB position.	
4	Adjust P OUT variable control for a -10 dB meter reading (output level of -20 dBm).	
5	Connect ac VTVM to RF OUTPUT to monitor signal levels.	
6	Set function switch to RCVR and adjust kHz SET to 10 kHz. **NOTE:** It may be necessary to adjust R50 to make the P IN meter read the same as the ac VTVM.	
7	Adjust the P OUT variable control for an output level of -10 dBm on the ac VTVM and adjust R72 so that the P IN meter reads the same (meter scale reads 0 dB).	
8	Adjust for best linearity and accuracy between -20 dBm and -10 dBm within ±0.25 dB. **NOTE:** R50 adjusts level and R72 adjusts linearity.	

7.23 **Demodulator Adjustment.** Demodulator adjustments to the 340B are made in the following manner:

STEP	PROCEDURE	NORMAL INDICATION
1	Set MOD FREQ switch to 25.	
2	Disconnect coax lead from pin Z of J21 and connect the oscilloscope to pin Z in its place.	
3	Adjust R18 until the modulation envelope coincide (double images of envelopes brought together). See Figure 6-12.	
4	Reconnect coax load to pin Z.	

STEP	PROCEDURE	NORMAL INDICATION
5	Connect oscilloscope to pin Y of J21.	A symmetrical 25 Hz sine wave should be observed. See Figure 6-12.
6	Connect the oscilloscope to pin N of J21.	
7	Check for a symmetrical sine wave in the 25 Hz 83-1/3 Hz and 250 Hz MOD FREQ switch positions.	
8	Connect the oscilloscope to pin W and to pin V and observe B and $\overline{B}$.	The square wave at both pins should be symmetrical. See Figure 6-12. NOTE: It may be necessary to adjust R46 to obtain symmetry.
9	Set MOD FREQ switch to 83-1/3 position.	The square waves at pins W and V should be symmetrical for both frequencies.
10	Set function switch to XMTR.	Frequency display should read the same as in the RCVR position.

7.24 **Analog to Digital Converter Calibration, Board A5.** The following procedure should be followed when calibrating board A5.

STEP	PROCEDURE	NORMAL INDICATION
1	Connect RF OUTPUT to RF INPUT with a short coax cable test lead.	
2	Unsolder and uplift end of R17 next to Emitter of Q3.	
3	Apply -3.0 vdc to uplifted end of R17.	Delay display should read near -20,000 μsec.
4	Adjust R32 for -20,000 μsec.	NOTE: This adjustment sets best stability of A-D converter. Also checks for closed loop operation in A-D converter.
5	Resolder R17 and disconnect -30 vdc.	
6	Same as Step 2 on originaal (unsolder Blue/Orange lead from Pin A etc).	
7	Unsolder Blue/Orange lead from pin A on J23.	
8	Temporarily connect a 12K resistor between pin A and pin R on J23.	
9	Set MOD FREQ switch to 25.	

STEP	PROCEDURE	NORMAL INDICATION
10	Adjust R11 for a DELAY reading of 3 microseconds.	
11	Turn MOD FREQ switch to 83-1/3.	DELAY reading should remain the same ±1 digit.
12	Turn MOD FREQ switch to 250.	DELAY reading should be .3 ±1 digit.
13	Disconnect the 12K resistor from pins A and R on J23.	
	NOTE: If no reading is obtained with pin A of J23 open, see troubleshooting procedure, paragraph 7.28	
14	Turn MOD FREQ switch to 83-1/3 and adjust R5 for a DELAY reading of +6000 microseconds ±1 digit.	
15	Turn MOD FREQ switch to 25 and adjust R3 for a DELAY reading of +20,000 microseconds ±2 digits.	
	NOTE: Decimal point in display moves one place to the left in this position.	
16	Reconnect blue/orange lead to pin A on J23.	

7.25 **Analog Envelope Delay and Analog Frequency Check, Board A4.** The performance of board A4 should be checked in the following manner:

STEP	PROCEDURE	NORMAL INDICATION
1	Connect RF OUTPUT to RF INPUT with short coax cable test lead.	
2	Set Z OUT and Z IN to 600.	
3	Set P OUT and P IN to -10 dB position.	
4	Adjust P OUT control for a 0 dBm indication on the output meter (-10 dBm level).	
5	Set kHz SET control to 10 kHz and MOD FREQ to 25 kHz.	
	Symmetry Adjust	
6	Adjust ϕ ADJ control for a minimum positive DELAY reading and determine the crossover point (DELAY reading at which the sign continuously changes back and forth from + to -).	

STEP	PROCEDURE	NORMAL INDICATION
7	Carefully adjust R71 (Board A4) and ϕADJ control to bring the crossover point to a DELAY reading as close to 0 μsec as possible.	Crossover point should be within the range of 0 ±200 μsec.
	Analog Envelope Delay Output Check	
8	Connect dc VTVM to ANALOG ϕ terminal on rear panel.	
9	On Board A4 connect clip lead from Junction R4 and R5 to ground.	
10	Adjust R10 for a 0V dc indication on the VTVM.	
11	Remove clip lead in step 9.	
12	Set ϕADJ control for a DELAY reading of ±10,000 μsec.	
13	Adjust R9 (Board A4) for a VTVM indication of +5.0 Vdc ±50 mV.	NOTE: The analog output will always indicate positive dc regardless of direction of magnitude.
14	Set ϕADJ control for a DELAY reading of +2000 μsec.	Output voltage should be +1.0 Vdc ±10 mV.
	Analog Frequency Output Adjust	
15	Connect dc VTVM to ANALOG (f) terminal on rear panel.	
16	Remove VCO (Board A8) from unit.	
17	Adjust R64 (Board A4) for a 0 Vdc indication on the VTVM.	
18	Install VCO board into its connector.	
19	With FREQUENCY kHz switch in the 0.3-5 kHz position, adjust kHz SET control for a frequency of 5.0 kHz.	
20	Adjust R48 (Board A4) for a dc voltage reading of +10.0 volts ±100 mV.	
21	Turn FREQUENCY kHz switch to the 5-110 position.	
22	Adjust kHz SET control for a frequency of 110.0 kHz.	
23	Adjust R50 (Board A4) for a dc voltage reading of +10.0 volts ±100 mV.	
24	Adjust kHz SET control to various frequencies.	Voltage vs frequency should vary linearly to within ± 5% of the best straight line.

7.26 **A.G.C. Adjustment, Board A6.** When making A.G.C. adjustments to board A6, perform the following procedure.

STEP	PROCEDURE	NORMAL INDICATION
1	Connect RF OUTPUT to RF INPUT with a short coax cable test lead.	
2	Set Z OUT and Z IN switch to 600.	
3	Set MOD FREQ switch to position 25, and adjust the kHz SET control to 10 kHz and set ϕADJ control for a DELAY reading of +1000 μsec.	
4	Set P OUT and P IN switched to the -10 position and set P OUT variable control for a meter reading of -5 dM (output level of -15 dBm).	
5	Connect oscilloscope to pin N of J21 (Board A6) for a p-p voltage of 15 volts.	
6	With P OUT variable control, adjust the power level over the range of -12.5 to -17.5 dBm and note the change in DELAY reading.	
7	Bring power level back to -15 dBm and change output voltage by R6. (Repeat procedure in step 6).	
8	Adjust output voltage level over the range of 10-18 volts p-p and repeat steps 6 and 7.	
9	Select the output p-p voltage for which there was a minimum change in DELAY reading as the power level was changed over the -12.5 to -17.5 dBm range.	A change of 20 μsec or less should be readily obtained.
10	Set MOD FREQ switch to 83-1/3 and 250.	There should be no significant change in output level at pin N of J21 (Board A6). The output must be an undistorted sine wave in all cases.

7.27 **FINAL CHECKS.** As final checks following the alignment procedure, carry out the general checkout procedure of paragraphs 6.01 through 6.09.

Troubleshooting Procedures

7.28 Troubleshooting should proceed from mechanical checks, loose or improperly seated boards, broken or detached wires, switches, panel controls, meters; to electrical checks to isolate the problem area in the Test Set. Proper operation in the CHECK position of the function switch eliminates the divider and control logic, and the display logic and the power supply. The Receiver and Transmitter sections can be checked by applying a suitable input to the Receiver, and by checking for proper output from the Transmitter.

7.29 Refer to Figures 6-4 and 6-5 for pin layout and base diagrams of the more commonly used solid state devices.

7.30 The most important waveforms and timing are given in the schematics and the callout of the major components on the circuit boards. Consult Section 3 for a description of the signal flow and a brief description of the basic operation of each section. A few other

procedures and troubleshooting checks are outlined below.

7.31 Check for the presence of the proper dc voltages at the connector pins of the circuit boards. See Figure 6-6.

Display Logic, Boards A1-1 to A1-6

7.32 If one or more digits reads incorrectly in the CHECK position of the function switch:

Step 1
Substitute one of the other Display Logic boards. If incorrect reading persists, trouble is in preceding circuits.

Step 2
If digit reads correctly, replace original board and remove CμL 958 from its socket.

Step 3
Apply proper combination of "ones" (+2 volts) and "zero" (0 volts) to pins 3, 2, 1, 8 (in this order) of the CμL 958 socket. (For example: to read "4" apply +2 volts to pin 1 and 0 volts to pins 3, 2, 8.) See Figures 6-4 and 6-5 for IO pin connection diagrams.

Step 4
If digit now reads correctly CμL 958 is faulty, if not one of the other integrated circuits is at fault.

Step 5
With the CμL 958 still out of the socket apply proper combination of "one" and "zeros" to pins 6, 7, 15, 14 (in this order) of one of the CμL 960 Decoder/Drivers. Ground proper pins to produce "zeros", ungrounded pins are held as "ones" through pull-up resistors. If digit now reads correctly the CμL 959 is faulty. If digit still reads incorrectly, the CμL 960 is at fault. Faulty component may be replaced or board returned to factory for repair.

7.33 **Divider and Control Logic, Board A2.** If trouble is suspected in this board, set function switch to CHECK and check the typical waveshapes and timing, Figure 6-8. Check for the proper output on J24 at pins C, D, E and J. If the count, store and reset pulses are correct, the remainder of the logic is functioning properly. Note that it is rather difficult to properly sync the very narrow reset pulse. Checking the other waveshapes and timing should serve to localize trouble to a component.

7.34 In the divider section check the outputs at pins N, W, V, R, U, S, T for proper outputs, see schematic diagram Figure 6-8. Pin U is 50 Hz, pin R 5 Hz, pin S and T 25 Hz of opposite phase, all rectangular waveshapes. Trouble in this section may be located by checking for the proper frequency between each divider micro-circuit module.

7.35 **Modulating Frequency Sources, Board A3.** Check for the presence of input and output frequencies as indicated on Figure 6-9.

7.36 **Sign Logic, Analog ∅ and Analog f. Board A3** Check for the presence of the input and output signals as indicated in Figure 6-9. Analog ∅ and Analog f outputs will be square waves which vary in width according to the delay or frequency being measured. Check the alignment procedure, paragraph 4.17.

7.37 **Analog to Digital Converter, Board A5.** If no DELAY reading is obtained, check for the presence of input and output signals as indicated in Figure 6-11. Graphs A, B, C, & E.

7.38 If alignment procedure does not correct improper DELAY readings, check the waveforms given in Figure 6-11. Graphs D, F, and G, paying attention to amplitude and timing.

Integrated circuit voltages with DELAY Display Pin A J-23 Disconnected.

A1	Pin 3 –.03V	A2	Pin 2	0.0V
	Pin 4 –5.2V		Pin 6	1.2V
	Pin 7 –2.4V		Pin 8	8.4V

Integrated circuit voltages with no DELAY Display Pin A J-23 Disconnected.

A2	Pin 6 +11.5V
	Pin 8 +7.5V

7.39 **Receiver AGC, Demodulator and Meter Amplifier, Board A6.** Check for the presence of the waveforms shown in Figure 6-12. Check for the presence of input and output signals as indicated in Figure 6-12. Refer to the alignment procedure, paragraph 7.09.

7.40 **Output Amplifier and Meter Circuitry, Board A7.** Check for the presence of the waveforms shown in Figure 6-13. Check for the inputs and outputs as indicated in Figure 6-13. Refer to alignment procedure, paragraph 6.09.

7.41 **VCO and Sweeper, Board A8.** Check the waveforms and amplitudes as given in Figure 6-14. Refer to the alignment procedure, paragraph 7.09

7.42 **Power Supplies, Boards A9, A10.** Check for the presence of the ac input voltages and for the dc output voltages indicated in Figures 6-15 and 6-16. Refer to alignment procedure, paragraph 7.09.

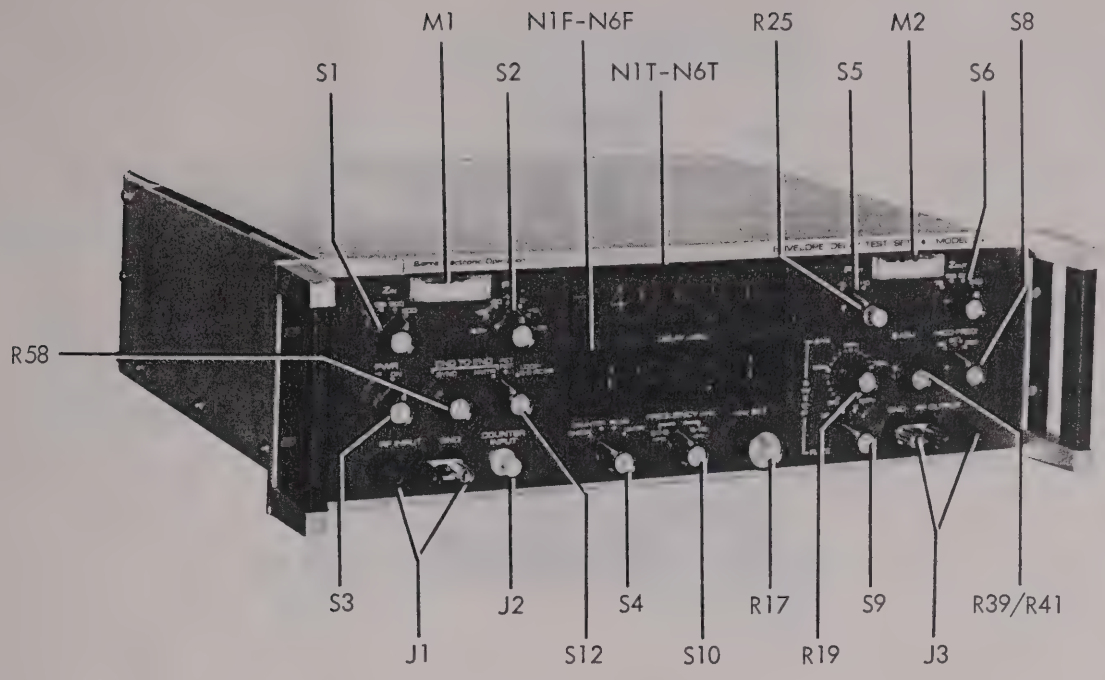


Figure 7-2. Front Panel Control Location

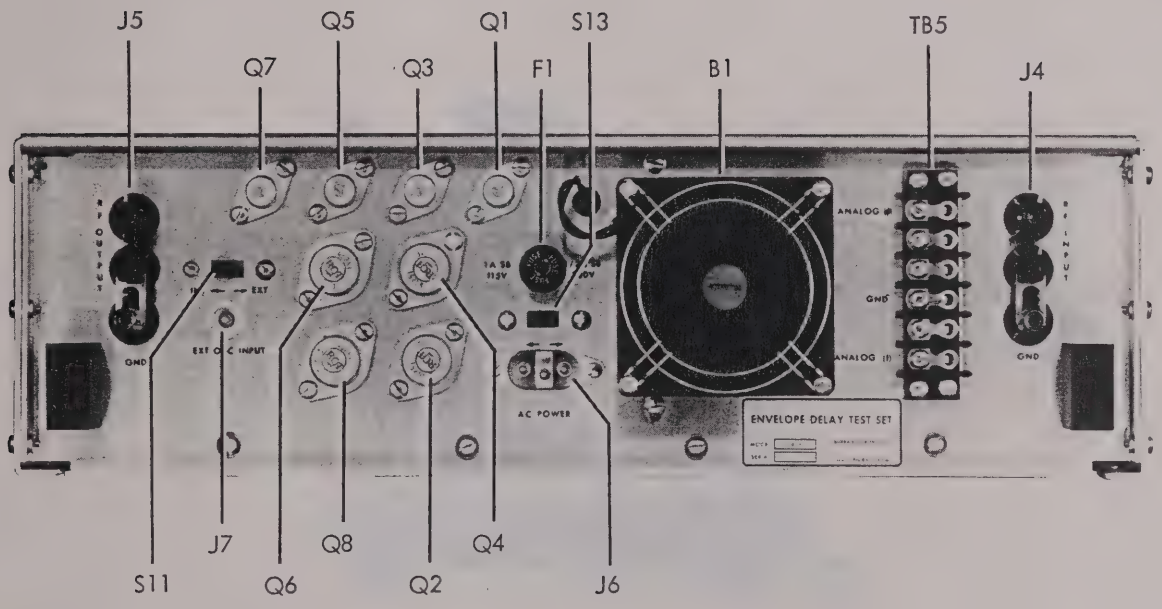


Figure 7-3. Rear Panel Component Location

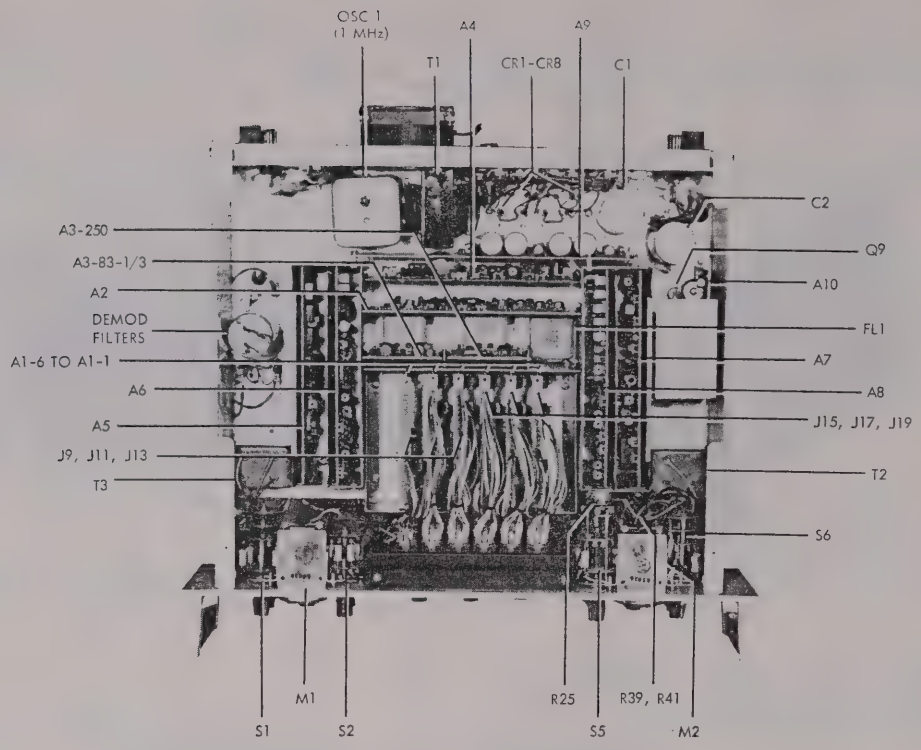


Figure 7-4. Top View, Test Set Chassis, Board and Component Location

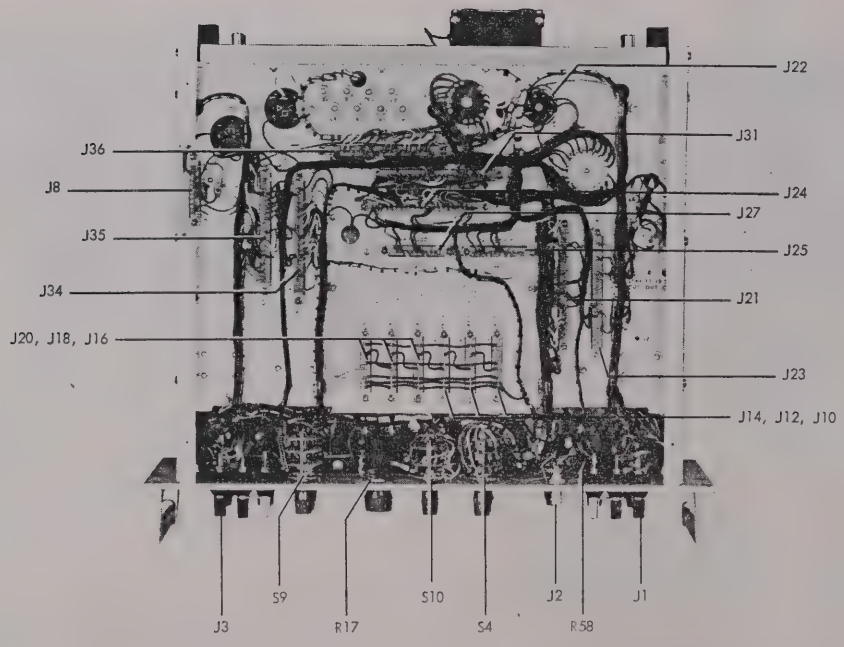


Figure 7-5. Bottom View, Test Set Chassis, Connector Location

SECTION 8
REPLACEABLE PARTS LIST

8.01 Standard components have been used in this instrument whenever possible. Both standard and special components may be ordered direct from the factory. When ordering parts always include:

1. Sierra Stock Number.
2. Circuit Reference Designation and Description of the part.
3. Name, Model and Serial Number of the instrument.

8.02 Parts for this instrument, or further service information may be obtained from:

Lear Siegler, Inc.
Sierra Electronic Division
3885 Bohannon Drive
Menlo Park, California 94025

Telephone (415) 321-5374
TWX 910-373-1282

8.03 The parts are listed in reference designation order by assembly.

Schem Ref. No.	Description	Sierra Stock No.	Mfr.	Dwg. or Mfr. No.	Tot. Quan.
	DISPLAY LOGIC A1-1 TO A1-6				
C1	CAPACITOR, Ceramic Disk, .01 μF, 150V	901440103	Centralab	DDM-103	30
C2	Same as C1				
C3	Same as C1				
C4	Same as C1				
C5	Same as C1				
C6	CAPACITOR, Ceramic Disc, 47 pF	901900470	Elmenco	DM15E-470J	6
Df	DIGITAL LOGIC, CμL 960 (FSL 4919)	920300001	Fairchild	U6B996059X	12
Df	Same as Df				
M	DIGITAL LOGIC, CμL 958 (FSL 4917)	920300003	Fairchild	U5B995859X	6
	Lamp –28V For decimal pts	913800038	Bright Eye #62		
N1F	NIXIE TUBE, Std., Rect. Numeral	910700113	Burroughs	B-5991	11
N2F	Same as N1F				
N3F	Same as N1F				
N4F	Same as N1F				
N5F	Same as N1F				
N6F	Same as N1F				
N1T	Same as N1F				
N2T	Same as N1F				
N3T	Same as N1F				
N4T	Same as N1F				
N5T	Same as N1F				
N6T	NIXIE TUBE, Std., Rct. (+ and – Sign)	910700114	Burroughs	B-5992	1
R1	RESISTOR, Fixed Composition, 2.2K ±5%, 1/4W	906900222	Speer		48
R2	Same as R1				
R3	Same as R1				
R4	Same as R1				
R5	Same as R1				
R6	Same as R1				
R7	Same as R1				
R8	Same as R1				
R9	Same as R1 (A1-6 Only)				
Sf	DIGITAL LOGIC, CμL 959 (FSL 4918)	920300002	Fairchild	U6B995959X	11
St	Same as Sf				
	SOCKET, Nixie Tube	914000051	Augat	31G-AG-1D	12
	SOCKET, Integrated Circuit	914200050	Augat	8058-1G-49	6
	BOARDS, A1-1 Through A1-5	914200052	Sierra	C02378100	5
	BOARD, A1-6		Sierra	C02380200	1
		915100182			
	DIVIDER AND CONTROL LOGIC A2				
C1	CAPACITOR, 750 pF	901100473	G. E.	65F12AA473	1
C2	CAPACITOR, Mylar, .047 μF, 50V, ±10%	901440103	Centralab	DDM-103	9
C3	CAPACITOR, Durmica, 560 pF, ±5%, 300V	901900561	El Menco	DM15-561J	1
C4	Same as C2				
C5	Same as C2				
C6	CAPACITOR, Tant., 10 μF ±20%, 15V	902740106	Texas Instrument	SCM106BP015A4	2
C7	Same as C2				
C8	Same as C2				
C9	Same as C2				

Schem Ref. No.	Description	Sierra Stock No.	Mfr.	Dwg. or Mfr. No.	Tot. Quan.
	DIVIDER AND CONTROL LOGIC A2 (continued)				
C10	Same as C2				
C11	Same as C2				
C12	Same as C6				
C13	Same as C2				
C14	CAPACITOR, Tant., 100 μF, ±20%, 10V	902700107	Sprague	150D	1
F1	DIGITAL LOGIC, CμL 923	920300005	Fairchild	U8A992328X	2
F2	Same as F1				
G1	DIGITAL LOGIC, CμL 914	920300004	Fairchild	U8A991428X	8
G2	Same as G1				
G3	Same as G1				
G4	Same as G1				
G5	Same as G1				
G6	Same as G1				
G7	Same as G1				
G8	Same as G1				
M1	DIGITAL LOGIC, CμL 958	920300003	Fairchild	U5B995859X	6
M2	Same as M1				
M3	Same as M1				
M4	Same as M1				
M5	Same as M1				
M6	Same as M1				
Q1	TRANSISTOR, NPN, Silicon	910300036	Fairchild	2N3646	18
Q2	Same as Q1				
Q3	Same as Q1				
Q4	Same as Q1				
Q5	Same as Q1				
Q6	Same as Q1				
Q7	Same as Q1				
Q8	Same as Q1				
Q9	Same as Q1				
Q10	Same as Q1				
Q11	Same as Q1				
Q12	Same as Q1				
Q13	Same as Q1				
Q14	Same as Q1				
Q15	Same as Q1				
Q16	Same as Q1				
Q17	Same as Q1				
Q18	Same as Q1				
R1	RESISTOR, Fixed Composition, 390Ω ±5%, 1/4W	906900391	Speer		3
R2	RESISTOR, Fixed Composition, 470Ω ±5%, 1/4W	906900471	Speer		14
R3	Same as R1				
R4	RESISTOR, Fixed Composition, 680Ω ±5%, 1/4W	906900681	Speer		15
R5	Same as R2				
R6	Same as R4				
R7	Same as R4				
R8	Not Used				
R9	RESISTOR, Fixed Composition, 820Ω ±5%, 1/4W	906900821	Speer		1
R10	Same as R1				
R11	Same as R2				
R12	Same as R4				
R13	Same as R2				
R14	Same as R4				

Schem Ref. No.	Description	Sierra Stock No.	Mfr.	Dwg. or Mfr. No.	Tot. Quan.
	DIVIDER AND CONTROL LOGIC A2 (continued)				
R15	Same as R2				
R16	Same as R2				
R17	Same as R2				
R18	RESISTOR, Fixed Composition, 1.5K ±5%, 1/4W	906900152	Speer		3
R19	Same as R4				
R20	Same as R4				
R21	Same as R2				
R22	Same as R2				
R23	Same as R4				
R24	Same as R2				
R25	Same as R2				
R26	Same as R4				
R27	Same as R18				
R28	Same as R18				
R29	Same as R2				
R30	Same as R2				
R31	Same as R4				
R32	Same as R4				
R33	RESISTOR, Fixed Composition, 560Ω ±5%, 1/4W	906900561	Speer		3
R34	RESISTOR, Fixed Composition, 2.2K ±5%, 1/4W	906900222	Speer		13
R35	Same as R34				
R36	Same as R34				
R37	Same as R34				
R38	Same as R34				
R39	Same as R34				
R40	Same as R34				
R41	Same as R34				
R42	Same as R34				
R43	Same as R34				
R44	Same as R34				
R45	Same as R34				
R46	Same as R34				
R47	RESISTOR, Fixed Composition, 1K ±5%, 1/4W	906900102	Speer		4
R48	Same as R2				
R49	Same as R4				
R50	Same as R47				
R51	Factory Selected				
R52	RESISTOR, Fixed Composition, 1.2K ±5%, 1/4W	906900122	Speer		1
R53	Same as R47				
R54	Same as R47				
R55	Same as R33				
R56	Same as R4				
R57	Same as R4				
R58	Same as R33				
R59	Same as R4				
	BOARD, A2		Sierra	D02378200	1
	MODULATING FREQUENCY SOURCE A3-83-1/3				
C1	CAPACITOR, Ceramic Disk .01 μF, 150V	901440103	Centralab		4
C2	Same as C1				
C3	Same as C1				

Schem Ref. No.	Description	Sierra Stock No.	Mfr.	Dwg. or Mfr. No.	Tot. Quan.
	MODULATING FREQUENCY SOURCE A3-83-1/3 (continued)				
C4	Same as C1				
C5	CAPACITOR, Tant. 10 μF ±20%, 15V	902740106	Texas Instrument	SCM106BP015A4	2
C6	Same as C5				
C7	CAPACITOR, Tant. 22 μF ±20%, 15V	902740226	Texas Instrument	SCM226BP015A4	1
F1	DIGITAL LOGIC CμL 923	920300005	Fairchild	U8A992328X	4
F2	Same as F1				
F3	Same as F1				
F4	Same as F1				
FL1	FILTER, Low-Pass 83-1/3 Hz	910100041	S. A. E.	948	1
Q1	TRANSISTOR, NPN, Silicon	910300036	Fairchild	2N3646	3
Q2	Same as Q1				
Q3	Same as Q1				
R1	RESISTOR, Fixed Composition, 1K ±5%, 1/4W	906900102	Speer		4
R2	Same as R1				
R3	RESISTOR, Fixed Composition, 1.2K ±5% 1/4W	906900122	Speer		2
R4	Same as R3				
R5	Lab Selected				
R6	Same as R1				
R7	Same as R1				
	BOARD, A3, 83-1/3		Sierra	C02378300	1
	MODULATING FREQUENCY SOURCE A3-250 (continued)				
C1	CAPACITOR, Ceramic Disk .01 μF, 150V	901440103	Centralab	DDM-103	2
C2	Same as C1				
C3	CAPACITOR, Tant. 10 μF ±20%, 15V	902740106	Texas Instrument	SCM106BP015A4	3
C4	Same as C3				
C5	Same as C3				
F1	DIGITAL LOGIC CμL 923	920300005	Fairchild	U8A992328X	2
F2	Same as F1				
FL1	FILTER, Low-Pass, 250 Hz	910100042	S. A. E.	944	1
Q1	TRANSISTOR, NPN, Silicon	910300036	Fairchild	2N3646	3
Q2	Same as Q1				
Q3	Same as Q1				
R1	RESISTOR, Fixed Composition, 1K ±5%, 1/4W	906900102	Speer		4
R2	Same as R1				
R3	RESISTOR, Fixed Composition, 1.2K ±5%, 1/4W	906900122	Speer		2
R4	Same as R3				
R5	Lab Selected				
R6	Same as R1				
R7	Same as R1				
	BOARD, A3, 250		Sierra	C02378400	1

Schem Ref. No.	Description	Sierra Stock No.	Mfr.	Dwg. or Mfr. No.	Tot. Quan.
	SIGN LOGIC, ANALOG PHASE & FREQUENCY A4		Sierra	D02660100	
A1	MICRO AMPLIFIER, MA710C	920300007	Fairchild	U5B771039X	1
A2	OPERATIONAL AMPLIFIER, μA 709C	920300008	Fairchild		2
A3	Same as A2				
C1	CAPACITOR, Tant. 10 μF ±20%, 15V	902740106	Texas Instrument	SCM106BP015A4	5
C2	Same as C1				
C3	Same as C1				
C4	CAPACITOR, Tant. 22 μF ±20%, 15V	902740226	Texas Instrument	SCM226BP015A4	1
C5	CAPACITOR, Ceramic, .001 μF, 6 mV, 500V	901400102	C. D.	TM5D1	1
C6	Same as C1				
C7	Same as C1				
C8	CAPACITOR, Durmica, 39 pF ±2%, 500V	901900390	El Menco	DM15E390G	1
C9	CAPACITOR, Durmica, 220 pF ±5%, 500V	901900221	El Menco	DM15-221J	3
C10	CAPACITOR, Tant. 330 μF 6V	902700337			
C11	CAPACITOR, Ceramic Disc, .01 μF, 150V	901440103			2
C12	Same as C11				
C13	CAPACITOR, Mylar, .0636 μF ±3%, 200V	901106362	Electro-Cube	217A	1
C14	CAPACITOR, Mylar, .0318 μF ±3%, 200V	901103182	Electro-Cube	217A	2
C15	Same as C14				
C16	CAPACITOR, Tant. 1.0 μF	902750105	Sprague		6
C17	CAPACITOR, Tant. 0.12 μF	902700124	Sprague		2
C18	CAPACITOR, Ceramic, 5600 pF	901900562	Sprague		2
C19	Same as C16				
C20	Same as C9				
C21	Same as C16				
C22	CAPACITOR, Disc Ceramic, .003 μF	901900302	Sprague		1
C23	Same as C16				
C24	Same as C17				
C25	Same as C18				
C26	Same as C16				
C27	Same as C16				
C28	Same as C9				
C29	CAPACITOR, Disc Ceramic	901410104	Sprague		1
C30					
C31	CAPACITOR, Fixed Ceramic, .01 μF, 600V, ±20%	901420103	Centralab	DD-6103	2
C32	Same as C31				
CR1	DIODE	910500045	Fairchild	1N914	2
CR2	Same as CR1				
F1	DIGITAL LOGIC, CμL 923	920300005	Fairchild	U8A992328X	1
G1	DIGITAL LOGIC, CμL 914	920300004	Fairchild	U8A991428X	2
G2	Same as G1				
L1	INDUCTOR, 82 μH	909000124	Delevan	1537-72	2
Q1	TRANSISTOR, NPN, Silicon	910300036	Fairchild	2N3646	9
Q2	Same as Q1				
Q3	TRANSISTOR, PNP	910300047	Fairchild	2N3640	5
Q4	Same as A3				
Q5	TRANSISTOR, NPN	910300046	Fairchild	2N3565	1
Q6	Not Used				
Q7	Not Used				
Q8	Not Used				

Schem Ref. No.	Description	Sierra Stock No.	Mfr.	Dwg. or Mfr. No.	Tot. Quan.
	SIGN LOGIC, ANALOG PHASE 7 FREQUENCY A4 (continued)				
Q9	Not Used				
Q10	Not Used				
Q11	Not Used				
Q12	Not Used				
Q13	Not Used				
Q14	TRANSISTOR, NPN, Silicon Power	910300051	Fairchild	2N3568	2
Q15	Same as Q14				
Q16	Same as Q3				
Q17	TRANSISTOR, NPN, Silicon	910300071	Fairchild	S20967	4
Q18	Same as Q17				
Q19	Same as Q17				
Q20	Same as Q3				
Q21	Same as Q17				
Q22	Same as Q1				
Q23	Same as Q1				
Q24	Same as Q1				
Q25	Same as Q1				
Q26	Same as Q3				
Q27	Same as Q1				
Q28	Same as Q1				
Q29	Same as Q1				
R1	RESISTOR, Fixed Composition, 680Ω ±5%, 1/4W	906900681	Speer		8
R2	Same as R1				
R3	Same as R1				
R4	RESISTOR, Fixed Composition, 2.2K ±5%, 1/4W	906900222	Speer		3
R5	RESISTOR, Fixed Composition, 390 ±5%, 1/4W	906900391	Speer		2
R6	RESISTOR, Fixed Composition, 3.9K ±5%, 1/4W	906900392	Speer		3
R7	Same as R4				
R8	RESISTOR, Fixed Composition, 1K ±5%, 1/4W	906900102	Speer		6
R9	POTENTIOMETER, 10K	907900229	SPA		1
R10	POTENTIOMETER, 5K	907900225	SPA		1
R11	RESISTOR, Metal Film, 100K ±1%	908300013	Electra	MF6C	2
R12	RESISTOR, Metal Film, 49.9K ±1%	908300074	Electra	MF6C	1
R13	Same as R11				
R14	RESISTOR, Fixed Composition, 4.7K ±5%, 1/4W	906900472	Speer		3
R15	RESISTOR, Fixed Composition, 33K ±5%, 1/4W	906900333	Speer		4
R16	Same as R15				
R17	RESISTOR, Fixed Composition, 47K ±5%, 1/4W	906900413	Speer		3
R18	RESISTOR, Metal Film, 127K ±1%, 1/8W	908300064	Electra	MF6C	1
R19	RESISTOR, Fixed Composition, 1.5K ±5%, 1/4W	906900152	Speer		4
R20	Not Used				
R21	Not Used				
R22	Not Used				
R23	Not Used				
R24	Same as R1				
R25	Same as R1				
R26	Same as R8				
R27	RESISTOR, Fixed Composition, 220Ω ±5%, 1/4W	906900221	Speer		2
R28	Same as R8				
R29	RESISTOR, Fixed Composition, 2.7K ±5%, 1/4W	906900272	Speer		2
R30	Same as R29				
R31	RESISTOR, Fixed Composition, 150K ±5%, 1/4W	906900154	Speer		2
R32	RESISTOR, Fixed Composition, 560Ω, ±5%, 1/4W	906900561	Speer		2
R33	RESISTOR, Fixed Composition, 6.8Ω ±5%, 1/4W	906900682	Speer		2
R34	Same as R1				

Schem Ref. No.	Description	Sierra Stock No.	Mfr.	Dwg. or Mfr. No.	Tot. Quan.
	SIGN LOGIC, ANALOG PHASE & FREQUENCY A4 (continued)				
R35	Same as R19				
R36	Same as R6				
R37	Same as R1				
R38	Same as R19				
R39	RESISTOR, Fixed Composition, 10K ±5%, 1/4W	906900103	Speer		2
R40	Same as R33				
R41	Same as R31				
R42	Same as R32				
R43	RESISTOR, Fixed Composition, 1.2K ±5%, 1/4W	906900122	Speer		2
R44	Same as R27				
R45	Same as R19				
R46	Same as R43				
R47	Same as R39				
R48	POTENTIOMETER, 200K	907900226	Beckman	62PA	3
R49	Same as R17				
R50	Same as R48				
R51	Same as R14				
R52	RESISTOR, Fixed Composition, 12K ±5%, 1/4W	906900123	Speer		3
R53	RESISTOR, Fixed Composition, 1.1K ±5%, 1/4W	906900112	Speer		1
R54	Same as R14				
R55	Same as R1				
R56	Same as R4				
R57	Same as R5				
R58	Same as R6				
R59	Same as R4				
R60	Same as R15				
R61	Same as R52				
R62	Same as R52				
R63	Same as R15				
R64	POTENTIOMETER, 2000Ω	907900228	Beckman	62PA	1
R65	RESISTOR, Fixed Composition, 39K ±5%, 1/4W	906900393	Speer		1
R66	RESISTOR, Fixed Composition, 120K ±5%, 1/4W	906900124	Speer		1
R67	Same as R19				
R68	Same as R8				
R69	Same as R17				
R70	Same as R8				
R71	Same as R48				
R72	Same as R8				
R73	RESISTOR, Fixed Composition, 470Ω ±5%, 1/4W	906900471	Speer		2
R74	Same as R73				
R75	RESISTOR, Fixed Composition, 56K ±5%, 1/4W	906900553	Speer		1
R76	RESISTOR, Fixed Composition, 100K ±5%,	906900104	Speer		1
	ANALOG TO DIGITAL CONVERTER A5				
A1	MICRO AMPLIFIER, μA702C	920300006	Fairchild	U5B770239X	1
A2	OPERATIONAL AMPLIFIER, μA709C	920300008	Fairchild	U5B770939X	1
A3	MICRO AMPLIFIER, μA710C	920300007	Fairchild	U5B771039X	1
C1	CAPACITOR, Tant. 10 μF ±20%, 15V	902740106	Texas Instrument	SCM106BP015A4	2
C2	Same as C1				
C3	CAPACITOR, Tant. 330 μF, 6V	902700337	Sprague	150D337X9006S2	1
C4	Not Used				
C5	CAPACITOR, Ceramic Disc, .01 μF, 150V	901440103	Centralab	DDM-103	8
C6	Same as C5				
C7	Same as C5				
C8	CAPACITOR, Durmica, 560 pF ±5%, 300V	901900561	El Menco	DM15-561J	1
C9	Same as C5				

Schem Ref. No.	Description	Sierra Stock No.	Mfr.	Dwg. or Mfr. No.	Tot. Quan.
	ANALOG TO DIGITAL CONVERTER A5 (continued)				
C10	Same as C5				
C11	CAPACITOR, Durmica 22 pF ±5%, 500V	901900220	El Menco	DM15-220J	2
C12	CAPACITOR, .01 μf	901330103	Sprague	CK36BX103K	1
C13	Same as C5				
C14	Same as C5				
C15	CAPACITOR, Durmica, 18 pF ±5%, 500V	901900180	El Menco	DM15-180J	1
C16	Same as C5				
C17	Same as C11				
C18	CAPACITOR, 100 pF NPO	901300101	Erie	8123-000-C0G0101K	1
CR1	DIODE	910500052	Motorola	1N825	2
CR2	Same as CR1				
CR3	DIODE	910500045	Fairchild	1N914	1
Q1	TRANSISTOR, NPN, Silicon	910300036	Fairchild	2N3646	9
Q2	Same as Q1				
Q3	TRANSISTOR, NPN	910300046	Fairchild	2N3565	2
Q4	Same as Q1				
Q5	Same as Q1				
Q6	Same as Q1				
Q7	Same as Q1				
Q8	Same as Q1				
Q9	Same as Q1				
Q10	TRANSISTOR, PNP	910300077	Fairchild	2N3638A	2
Q11	Same as Q3				
Q12	Same as Q1				
Q13	Same as Q10				
R1	RESISTOR, Fixed Composition, 680Ω ±5%, 1/4W	906900681	Speer		1
R2	RESISTOR, Metal Film, 1.82K ±1%, 1/4W	908300019	Electra	MF6C	2
R3	POTENTIOMETER, 500Ω	907900254	CTS	170PC501A	2
R4	RESISTOR, Metal Film, 487Ω ±1%	908300018	Electra	MF6C	1
R5	POTENTIOMETER, 200Ω	907900257	CTS	170PC201A	1
R6	RESISTOR, Metal Film, 100Ω ±1%, 1/4W	908300042	Electra	MF6C	1
R7	RESISTOR, Metal Film, 4.99K ±1%, 1/4W	908300020	Electra	MF6C	2
R8	RESISTOR, Fixed Composition, 1K ±5%, 1/4W	906900102	Speer		2
R9	RESISTOR, Metal Film, 6.34K ±1%, 1/4W	908300032	Electra	MF6C	2
R10	Same as R7				
R11	Same as R3				
R12	Same as R9				
R13	Same as R8				
R14	Same as R2				
R15	RESISTOR, Metal Film, 10.0K ±1%, 1/4W	908300005	Electra	MF6C	3
R16	RESISTOR, Fixed Composition, 1.5K ±5%, 1/4W	906900152	Speer		3
R17	RESISTOR, Metal Film, 1.21K ±1%, 1/4W	908300022	Electra	MF6C	4
R18	Same as R16				
R19	RESISTOR, Metal Film, 562Ω ±1%, 1/4W	908300023	Electra	MF6C	1
R20	Same as R16				
R21	RESISTOR, Fixed Composition, 560Ω ±5%, 1/4W	906900561	Speer		1
R22	RESISTOR, Metal Film, 11K ±1%, 1/4W	908300024	Electra	MF6C	1
R23	RESISTOR, Metal Film, 576Ω ±1%, 1/4W	908300025	Electra	MF6C	1
R24	RESISTOR, Fixed Composition, 22K ±5%, 1/4W	906900223	Speer		1
R25	Same as R17				
R26	Same as R17				
R27	RESISTOR, Fixed Composition, 1.2K ±5%, 1/4W	906900122	Speer		1
R28	Same as R27				

Schem Ref. No.	Description	Sierra Stock No.	Mfr.	Dwg. or Mfr. No.	Tot. Quan.
	ANALOG TO DIGITAL CONVERTER A5 (continued)				
R29	RESISTOR, Fixed Composition, 5.6K ±5%, 1/4W	906900562	Speer		2
R30	RESISTOR, Fixed Composition, 12K ±5%, 1/4W	906900123	Speer		1
R31	Same as R29				
R32	POTENTIOMETER, 200K	907900226	Beckman	62PA	1
R33	RESISTOR, Metal Film, 100K ±1%, 1/4W	908300013	Electra	MF6C	1
R34	Same as R27				
R35	Same as R17				
R36	RESISTOR, Metal Film, 243Ω ±1%, 1/4W	908300030	Electra	MF6C	1
R37	RESISTOR, Metal Film, 6.04K ±1%, 1/4W	908300026	Electra	MF6C	2
R38	Same as R37				
R39	Same as R15				
R40	Same as R15				
R41	RESISTOR, Metal Film, 8.06K ±1%, 1/4W	908300027	Electra	MF6C	1
R42	RESISTOR, Metal Film, 4.02K ±1%, 1/4W	908300028	Electra	MF6C	1
R43	RESISTOR, Fixed Composition, 202K ±5%, 1/4W	906900222	Speer		2
R44	Same as R43				
R45	Same as R27				
	BOARD, A5		Sierra	D02380300	1
	RECEIVER AGC, DEMO. & METER AMPLIFIER A6				
A1	OPERATIONAL AMPLIFIER, μA709C	920300008	Fairchild	U5B770939X	2
A2	Same as A1				
C1	CAPACITOR, Pol. Tant., 10 μF ±20%, 15V	902740106	Texas Instrument	SCM106BP015A4	6
C2	CAPACITOR, Pol. Tant., 220 μF 10V	902700227	Sprague	150D227X0010S2	3
C3	Same as C2				
C4	Same as C2				
C5	Same as C1				
C6	Same as C1				
C7	CAPACITOR, Pol. Tant., 100μF, 10V	902700107	Sprague	15D107X0010R2	3
C8	Not Used				
C9	CAPACITOR, Mylar, .0318 μF +3%, 200V	901103182	Electro-Cube	217A	1
C10	CAPACITOR, .0636 μF ±3%, 200V	901106362	Electro-Cube	217A	1
C11	Same as C7				
C12	CAPACITOR, 100 pF NPO	901310102	Erie	8133-000-C0G0102K	1
C13	CAPACITOR, Ceramic Disc .01 μF, 150V	901440103	Centralab	DDM-103	6
C14	CAPACITOR, Durmica 220 pF ±5%, 500V	901900221	El Menco	DM15-221J	1
C15	Same as C13				
C16	CAPACITOR, Durmica 10 pF ±5%, 500V	901900100	El Menco	DM15-100J	2
C17	Same as C1				
C18	Same as C1				
C19	Same as C1				
C20	CAPACITOR, Pol. Tant., 22 μF ±20%, 15V	902740226	Texas Instrument	SCM226BP015A4	4
C21	Same as C7				
C22	Same as C16				
C23	Same as C13				
C24	Same as C13				
C25	CAPACITOR, Durmica, 5 pF, ±10%, 500V	901900050	El Menco	DM15-050K	1
C26	Same as C20				
C27	Not Used				
C28	Not Used				
C29	Not Used				
C30	Not Used				

Schem Ref. No.	Description	Sierra Stock No.	Mfr.	Dwg. or Mfr. No.	Tot. Quan.
	RECEIVER AGC, DEMO. & METER AMPLIFIER A6 (continued)				
C31	Same as C20				
C32	Same as C13				
C33	Same as C20				
C34	Same as C13				
C35	CAPACITOR, Pol. Tant. 330 μF ±20%, 6V	902700337	Sprague	150D33X900652	1
CR1	Not Used				
CR2	Not Used				
CR3	DIODE	910500052	Motorola	1N825	1
CR4	DIODE	910500045	Fairchild	1N914	3
CR5	Same as CR4				
CR6	Same as CR4				
Q1	TRANSISTOR, NPN	910300046	Fairchild	2N3565	7
Q2	Same as Q1				
Q3	TRANSISTOR, FET	910300059	Raytheon	RN1030	1
Q4	TRANSISTOR, PNP	910300077	Fairchild	2N3638A	7
Q5	TRANSISTOR, NPN, Dual	910300054	Union Carbide	2N4045	1
Q6	Same as Q4				
Q7	Same as Q1				
Q8	Same as Q1				
Q9	Same as Q1				
Q10	Same as Q4				
Q11	Same as Q4				
Q12	Same as Q1				
Q13	Same as Q4				
Q14	TRANSISTOR, PNP	910300047	Fairchild	2N3640	2
Q15	Same as Q14				
Q16	TRANSISTOR, NPN, Silicon	910300036	Fairchild	2N3646	4
Q17	Same as Q16				
Q18	Same as Q16				
Q19	Same as Q16				
Q20	Not Used				
Q21	Not Used				
Q22	TRANSISTOR, PNP	910300065	Fairchild	S2322	2
Q23	Same as Q22				
Q24	Same as Q1				
Q25	TRANSISTOR, NPN	910300060		2N3643	1
Q26	Same as Q4				
Q27	Same as Q4				
R1	RESISTOR, Fixed Composition, 100K, ±5%, 1/4W	906900104	Speer		1
R2	RESISTOR, Fixed Composition, 10K, ±5%, 1/4W	906900103	Speer		7
R3	RESISTOR, Fixed Composition, 22K, ±5%, 1/4W	906900223	Speer		2
R4	Same as R2				
R5	Same as R2				
R6	POTENTIOMETER, 500Ω	907900231	Beckman	62PA	1
R7	RESISTOR, Metal Film, 825Ω ±1%, 1/4W	908300012	Electra	MF6C	1
R8	RESISTOR, Metal Film, 549Ω ±1%, 1/4W	908300011	Electra	MF6C	1
R9	Same as R2				
R10	Same as R3				
R11	Not Used				
R12	Not Used				
R13	RESISTOR, Fixed Composition, 270Ω ±5%, 1/4W	906900271	Speer		1
R14	RESISTOR, Fixed Composition, 5.6K ±5%, 1/4W	906900562	Speer		4
R15	Same as R14				
R16	RESISTOR, Fixed Composition, 3.3K, ±5%, 1/4W	906900332	Speer		6

Schem Ref. No.	Description	Sierra Stock No.	Mfr.	Dwg. or Mfr. No.	Tot. Quan.
	RECEIVER AGC, DEMO. & METER AMPLIFIER A6 (continued)				
R17	Same as R16				
R18	POTENTIOMETER, 200K	907900226	Beckman	62PA	2
R19	Same as R16				
R20	Same as R16				
R21	RESISTOR, Metal Film, 100K ±1%, 1/4W	908300013	Electra	MF6C	1
R22	RESISTOR, Metal Film, 200K ±1%, 1/4W	908300014	Electra	MF6C	2
R23	Same as R22				
R24	Same as R2				
R25	RESISTOR, Fixed Composition, 56 ±5%, 1/4W	906900560	Speer		1
R26	RESISTOR, Fixed Composition, 33K ±5%, 1/4W	906900333	Speer		2
R27	Same as R26				
R28	RESISTOR, Fixed Composition, 1K ±5%, 1/4W	906900102	Speer		3
R29	RESISTOR, Metal Film, 220K ±1%	908300014			2
R30	Same as R29				
R31	RESISTOR, Fixed Composition, 1.5K ±5%, 1/4W	906900152	Speer		4
R32	RESISTOR, Fixed Composition, 100K ±5%, 1/4W	906900104	Speer		2
R33	POTENTIOMETER, 50K	907900232	Beckman	62PA	1
R34	RESISTOR, Fixed Composition, 560Ω ±5%, 1/4W	906900561	Speer		2
R35	Same as R28				
R36	RESISTOR, Fixed Composition, 820Ω ±5%, 1/4W	906900821	Speer		2
R37	RESISTOR, Fixed Composition, 150K ±5%, 1/4W	906900154	Speer		1
R38	Same as R2				
R39	RESISTOR, Fixed Composition, 6.8K ±5%, 1/4W	906900682	Speer		2
R40	RESISTOR, Fixed Composition, 680Ω ±5%, 1/4W	906900681	Speer		2
R41	Same as R31				
R42	RESISTOR, Fixed Composition, 3.9K ±5%, 1/4W	906900392	Speer		1
R43	Same as R40				
R44	Same as R31				
R45	Same as R39				
R46	Same as R18				
R47	Same as R34				
R48	Same as R28				
R49	Same as R36				
R50	POTENTIOMETER, 100K	907900230	Beckman	62PA	2
R51	RESISTOR, Fixed Composition, 68K ±5%, 1/4W	906900683	Speer		1
R52	RESISTOR, Fixed Composition, 220K, ±5%, 1/4W	906900224	Speer		1
R53	RESISTOR, Fixed Composition, 100Ω ±5%, 1/4W	906900101	Speer		1
R54	Same as R32				
R55	Same as R31				
R56	Same as R16				
R57	RECEIVER, Fixed Composition, 47K ±5%, 1/4W	906900473	Speer		1
R58	Same as R16				
R59	RESISTOR, Fixed Composition, 1.8K ±5%, 1/4W	906900182	Speer		1
R60	Not Used				
R61	Not Used				
R62	Not Used				
R63	Same as R2				
R64	RESISTOR, Fixed Composition, 2.2K ±5%, 1/4W	906900222	Speer		1
R65	RESISTOR, Fixed Composition, 2.7K ±5%, 1/4W	906900272	Speer		3
R66	Same as R14				
R67	Same as R14				
R68	Same as R64				
R69	RESISTOR, Fixed Composition, 330Ω ±5%, 1/4W	906900301	Speer		1
R70	RESISTOR, Fixed Composition, 4.7K, ±5%, 1/4W	906900472	Speer		1
R71	RESISTOR, Fixed Composition, 1K ±5%, 1/4 W	906900102	Speer		1
R72	Same as R50				
R73	RESISTOR, Fixed Composition, 1.1M ±5%, 1/4W	906900115	Speer		1

Schem Ref. No.	Description	Sierra Stock No.	Mfr.	Dwg. or Mfr. No.	Tot. Quan.
	RECEIVER AGC, DEMO. & METER AMPLIFIER A6 (continued)				
	BOARD, A6		Sierra	D02380400	1
S	4 Hole Transistor Socket for Fet	914200037			
	OUTPUT AMPLIFIER & METER CIRCUITRY A7				
A1	OPERATIONAL AMPLIFIER, μA709C	920300008	Fairchild	U5770939X	1
C1	CAPACITOR, Tant. 10 μF, ±20%, 15V	902740106	Texas Instrument	SCM106BP015D4	2
C2	CAPACITOR, 3 μF, 100V, Mylar ±2%	902410305	Midwec	Type C	1
C3	CAPACITOR, Tant. 22 μF, ±20%, 15V	902740226	Texas Instrument	SCM226BP015D4	4
C4	CAPACITOR, Ceramic Disc, .01 μF, 150V	901440103	Centralab	DDM-103	4
C5	Same as C4				
C6	Same as C3				
C7	CAPACITOR, Tant., 1 μF ±20%, 35V	902750105	Texas Instrument	SCM105FP035D4	1
C8	CAPACITOR, Tant., 220 μF, 10V	902700227	Sprague	150D227X0010S2	3
C9	Same as C8				
C10	CAPACITOR, Durmica 390 pF, ±10%, 500V	901920391	El Menco	DM15-391K	1
C11	Same as C4				
C12	Same as C4				
C13	CAPACITOR, Durmica 10 pF, ±5%, 500V	901900100	El Menco	DM15-100J	1
C14	Same as C3				
C15	Same as C8				
C16	Same as C1				
C17	Same as C3				
CR1	DIODE	910500052	Motorola	1N825	1
CR2	DIODE	910500045	Fairchild	1N914	1
FL1	FILTER, Low-Pass 150 kHz	910100045	Sprague	JW1D-2042A	1
Q1	TRANSISTOR, NPN	910300046	Fairchild	2N3565	8
Q2	Same as Q1				
Q3	Same as Q1				
Q4	Same as Q1				
Q5	TRANSISTOR, FET	910300059	Raytheon	RN1030	1
Q6	TRANSISTOR, PNP	910300077	Fairchild	2N3638A	3
Q7	Same as Q1				
Q8	Same as Q1				
Q9	TRANSISTOR, NPN	910300033	G. E.	7A31	1
Q10	TRANSISTOR, PNP	910300031	Transitron	2N1991	1
Q11	Same as Q1				
Q12	Same as Q6				
Q13	Same as Q6				
Q14	Same as Q1				
Q15	TRANSISTOR, NPN	910300060	Fairchild	2N3643	1
Q16	TRANSISTOR, PNP	910300065	Fairchild	S2322	1
R1	RESISTOR, Metal Film 1.5K ±1%	908300050			1
R2	RESISTOR, Fixed Composition, 470Ω ±5%, 1/4W	906900471	Speer		
R3	RESISTOR, Metal Film 2.21K ±1%	908300052			1
R4	RESISTOR, Metal Film 1K ±1%	908300007			2
R5	RESISTOR, Metal Film 825Ω ±1%	908300012			1
R6	POTENTIOMETER, 100K	907900230	Beckman	62PA	2
R7	RESISTOR, Fixed Composition, 1.2K ±5%	906900122	Speer		1

Schem Ref. No.	Description	Sierra Stock No.	Mfr.	Dwg. or Mfr. No.	Tot. Quan.
	OUTPUT AMPLIFIER & METER CIRCUITRY A7 (continued)				
R8	RESISTOR, Metal Film 1M ±1%	908300055			1
R9	POTENTIOMETER, 500Ω	907900231	Beckman	62PA	1
R10	RESISTOR, Metal Film 5.62K ±1%	908300051			3
R11	RESISTOR, Fixed Composition, 560Ω ±5%, 1/4W	906900561	Speer		2
R12	Same as R11				
R13	RESISTOR, Metal Film 6.81K ±1%	908300056			2
R14	RESISTOR, Metal Film 12.1K ±1%	908300057			1
R15	RESISTOR, Metal Film 2.67K ±1%	908300058			1
R16	RESISTOR, Metal Film 3.92K ±1%	908300053			3
R17	POTENTIOMETER, 10K	907900229	Beckman	62PA	1
R18	Same as R16				
R19	Same as R16				
R20	Same as R10				
R21	Same as R10				
R22	Same as R4				
R23	RESISTOR, Metal Film, 27.4K ±1%	908300010	Electra	MF6C	2
R24	Same as R23				
R25	RESISTOR, Fixed Composition, 1.5K ±5%, 1/4W	906900152	Speer		1
R26	RESISTOR, Fixed Composition, 12K, ±5%, 1/4W	906900123	Speer		1
R27	RESISTOR, Fixed Composition, 1K ±5%, 1/4W	906900102	Speer		3
R28	RESISTOR, Metal Film, 22.1K ±1%, 1/4W	908300009	Electra	MF6C	2
R29	RESISTOR, Metal Film, 1.33K ±1%, 1/4W	908300008	Electra	MF6C	2
R30	Same as R29				
R31	Same as R28				
R32	RESISTOR, Fixed Composition, 22K, ±5%, 1/4W	906900223	Speer		1
R33	RESISTOR, Fixed Composition, 10K, ±5%, 1/4W	906900103	Speer		1
R34	Same as R27				
R35	POTENTIOMETER, 50K	907900232	Beckman	62PA	1
R36	Same as R27				
R37	RESISTOR, Fixed Composition, 47K ±5%, 1/4W	906900473	Speer		2
R38	RESISTOR, Fixed Composition, 100K ±5%, 1/4W	906900115	Speer		2
R39	RESISTOR, Fixed Composition, 1.1M, ±5%, 1/4W	906900115	Speer		2
R40	Same as R37				
R41	Same as R39				
R42	RESISTOR, Fixed Composition, 3.3K ±5%, 1/4W	906900332	Speer		2
R43	Same as R42				
R44	RESISTOR, Fixed Composition, 1.8K ±5%, 1/4W	906900182	Speer		1
R45	Same as R6				
	HEAT SINKS	921300002	Augat	9017-1P1U	2
	BOARD, A7		Sierra	D02380100	1
	VCO AND SWEEPER A8				
A1	OPERATIONAL AMPLIFIER, μA709C	920300008	Fairchild	U5B770939X	1
A2	MICROAMPLIFIER, μA710C	920300007	Fairchild	U5B771039X	1
C1	CAPACITOR, Tant. 22 μF, ±20%, 15V	902740226	Texas Instrument	SCM226BP015A4	3
C2	CAPACITOR, Ceramic .01 μF, 150V	901440103	Centralab	DDM-103	6
C3	CAPACITOR, 3 μF, ±2%, Mylar 100V	902410305	Midwec	Type C	1
C4	Same as C2				
C5	CAPACITOR, Tant. 10 μF, ±20%, 15V	902740106	Texas Instrument	SCM106BP015A4	2
C6	CAPACITOR, Durmica 47 pF ±5%, 500V	901900470	El Menco	DM15-470J	1
C7	CAPACITOR, 56 pF ±5%, 500V	901900560	El Menco	DM15-560J	1
C8	Not Used				

Schem Ref. No.	Description	Sierra Stock No.	Mfr.	Dwg. or Mfr. No.	Tot. Quan.
	VCO AND SWEEPER A8 (continued)				
C9	Same as C5				
C10	CAPACITOR, Ceramic, .005 μF ±20%, 500V	901410502	Erie	ED.005 Stype 811	1
C11	Same as C2				
C12	CAPACITOR, Durmica, 22 pF ±5%, 500V	901900220	El Menco	DM15-220J	1
C13	CAPACITOR, 1000 pF, NPO	901310102			1
C14	Not Used				
C15	Same as C2				
C16	CAPACITOR, Durmica, 560 pF ±5%, 300V	901900561	El Menco	DM15-561J	1
C17	Same as C2				
C18	Same as C1				
C19	Same as C1				
C20	Same as C2				
	CONNECTOR (Pin and Jack)	914800095		CTC-3310-2-03	
CR1	DIODE	910500045	Fairchild	1N914	5
CR2	Same as CR1				
CR3	Same as CR1				
CR4	Same as CR1				
CR5	Same as CR1				
CR6	DIODE, Zener, 8.5V	910500091	Hoffman	1N764A	1
CR7	DIODE, Zener	910500080	Hoffman	1N753A	1
F1	DIGITAL LOGIC, CμL 923	920300005	Fairchild	U8A992328X	1
Q1	TRANSISTOR, NPN	910300046	Fairchild	2N3565	7
Q2	Same as Q1				
Q3	Same as Q1				
Q4	TRANSISTOR, FET	910300059	Raytheon	RN1030	1
Q5	TRANSISTOR, PNP, Silicon	910300037	Fairchild	2N3638A	3
Q6	Same as Q1				
Q7	Same as Q1				
Q8	Same as Q1				
Q9	Not Used				
Q10	TRANSISTOR, NPN	910300036	Fairchild	2N3646	13
Q11	TRANSISTOR, PNP	910300047	Fairchild	2N3640	4
Q12	Same as Q10				
Q13	Same as Q10				
Q14	Same as Q10				
Q15	Same as Q10				
Q16	Same as Q5				
Q17	Same as Q1				
Q18	TRANSISTOR, FET	910300053	Union Carbide	2N2842	1
Q19	Same as Q10				
Q20	Same as Q5				
Q21	TRANSISTOR, FET	910300063	Siliconix	SU806	1
Q22	Same as Q10				
Q23	Same as Q10				
Q24	Same as Q10				
Q25	Same as Q10				
Q26	Same as Q11				
Q27	Same as Q10				
Q28	Same as Q11				
Q29	Same as Q10				
Q30	Same as Q11				
Q31	Same as Q10				

Schem Ref. No.	Description	Sierra Stock No.	Mfr.	Dwg. or Mfr. No.	Tot. Quan.
	VCO AND SWEEPER A8 (continued)				
R1	RESISTOR, Fixed Composition, 6.8K ±5%, 1/4W	906900682	Speer		4
R2	RESISTOR, Fixed Composition, 12K ±5%, 1/4W	906900123	Speer		3
R3	RESISTOR, Fixed Composition, 1.2M ±5%, 1/4W	906900125	Speer		1
R4	Same as R2				
R5	RESISTOR, Fixed Composition, 22K ±5%, 1/4W	906900223	Speer		2
R6	RESISTOR, Fixed Composition, 15K ±5%, 1/4W	906900153	Speer		1
R7	RESISTOR, Fixed Composition, 10K ±5%, 1/4W	906900103	Speer		3
R8	RESISTOR, Factory Selected				5
R9	RESISTOR, Composition, 39M ±5%, 1/4W	906900396	Speer		1
R10	POTENTIOMETER, 2.5M ±20%	907900244	Allen Bradley	Type RP	3
R11	Not Used				
R12	Not Used				
R13	RESISTOR, Fixed Composition, 10M ±5%, 1/4W	906900106	Speer		1
R14	Same as R10				
R15	RESISTOR, Fixed Composition, 3.9M ±5%, 1/4W	906900395	Speer		1
R16	Same as R10				
R17	RESISTOR, Fixed Composition, 2.2K ±5%, 1/4W	906900222	Speer		3
R18	RESISTOR, Fixed Composition, 3.3K ±5%, 1/4W	906900332	Speer		2
R19	Same as R1				
R20	RESISTOR, Fixed Composition, 56K ±5%, 1/4W	906900563	Speer		1
R21	RESISTOR, Fixed Composition, 39K ±5%, 1/4W	906900393	Speer		1
R22	RESISTOR, Fixed Composition, 910Ω ±5%, 1/4W	906900911	Speer		1
R23	RESISTOR, Fixed Composition, 1K ±5%, 1/4W	906900102	Speer		4
R24	Same as R7				
R25	POTENTIOMETER, 5K ±20%	907900186	Allen Bradley	Type RP	1
R26	Same as R18				
R27	RESISTOR, Fixed Composition, 1.2K ±5%, 1/4W	906900122	Speer		5
R28	RESISTOR, Fixed Composition, 820Ω ±5%, 1/4W	906900821	Speer		3
R29	RESISTOR, Fixed Composition, 470Ω ±5%, 1/4W	906900471	Speer		4
R30	Same as R29				
R31	Same as R2				
R32	Same as R27				
R33	POTENTIOMETER, 1K	907900227	Beckman	62PA	1
R34	RESISTOR, Fixed Composition, 1.5K ±5%, 1/4W	906900152	Speer		6
R35	Same as R23				
R36	POTENTIOMETER, 2K	907900228	Beckman	62PA	3
R37	RESISTOR, Fixed Composition, 2.7K	906900272	Speer		1
R38	Same as R36				
R39	Same as R34				
R40	RESISTOR, Fixed Composition, 4.7K ±5%, 1/4W	906900472	Speer		4
R41	Same as R7				
R42	RESISTOR, Metal Film, 10K ±1%, 1/4W	908300005	Electra	MF6C	1
R43	POTENTIOMETER, 10K	907900229	Beckman	62PA	1
R44	RESISTOR, Fixed Composition, 560Ω ±5%, 1/4W	906900561	Speer		4
R45	Same as R40				
R46	Same as R40				
R47	RESISTOR, Fixed Composition, 680Ω ±5%, 1/4W	906900681	Speer		4
R48	RESISTOR, W. W. 20.6K ±1%	906100113	Rich Ind.	P-1	2
R49	RESISTOR, W. W. 10K ±0.1%	906100074	Rich Ind.	P-1	2
R50	Lab Selected				
R51	Same as R34				
R52	Same as R48				
R53	Same as R49				
R54	RESISTOR, W. W. 4K ± 0.1%	906100073	Rich Ind.	P-1	1
R55	RESISTOR, Metal Film, 1.5K, ±1%	908300050			
R56	Same as R36				
R57	Same as R47				

Schem Ref. No.	Description	Sierra Stock No.	Mfr.	Dwg. or Mfr. No.	Tot. Quan.
	VCO AND SWEEPER A8 (continued)				
R58	Same as R28				
R59	Same as R44				
R60	RESISTOR, Fixed Composition, 47K ±5%, 1/4W	906900473	Speer		2
R61	Same as R1				
R62	Same as R17				
R63	RESISTOR, Fixed Composition, 3.9K ±5%, 1/4W	906900392	Speer		2
R64	Same as R47				
R65	Same as R1				
R66	Same as R34				
R67	RESISTOR, Metal Film, 13.3K ±1%, 1/4W	908300004	Electra	MF6C	1
R68	Same as R60				
R69	RESISTOR, Metal Film, 422Ω ±1%, 1/4W	908300006	Electra	MF6C	1
R70	RESISTOR, Metal Film, 1.13K ±1%, 1/4W	908300003	Electra	MF6C	1
R71	Same as R40				
R72	Same as R23				
R73	Same as R17				
R74	Same as R47				
R75	Same as R29				
R76	Same as R5				
R77	Same as R27				
R78	Same as R28				
R79	Same as R29				
R80	Same as R27				
R81	Same as R27				
R82	Same as R44				
R83	Same as R23				
R84	Same as R34				
R85	Same as R34				
R86	Same as R63				
R87	Same as R44				
R88	Not Used				
R89	RESISTOR, Factory Selected				4
R92					
R93	POTENTIOMETER, 1K	907900255	Bourns	275-1-102	1
R94	RESISTOR, Factory Selected (2.5-4K)				
R95	POTENTIOMETER, 10K	907900256	Bourns	275-1-103	1
R96	RESISTOR, Factory Selected (20-50K)				1
R97	RESISTOR, Factory Selected (400-800)				1
R98	POTENTIOMETER 100Ω	907900310	Bourns	275-1-101	2
R99	Same as R98				
	POTENTIOMETER 100Ω (used for mod kits only 9079X307)				
	BOARD, A8		Sierra	D02380500	1
	LOW VOLTAGE POWER SUPPLY A9				
C1	CAPACITOR, 1000 μF, 35V	902250108	Synchro	EMW01946-A	4
C2	CAPACITOR, .01 μF, 150V	901440103	Centralab	DDM-103	4
C3	Same as C1				
C4	Same as C2				
C5	Same as C1				
C6	Same as C1				
C7	Same as C2				
C8	Same as C2				
CR1	DIODE	910500045	Fairchild	1N914	6
CR2	Same as CR1				

Schem Ref. No.	Description	Sierra Stock No.	Mfr.	Dwg. or Mfr. No.	Tot. Quan.
	LOW VOLTAGE POWER SUPPLY A9 (continued)				
CR3	Same as CR1				
CR4	Same as CR1				
CR5	Same as CR1				
CR6	Same as CR1				
CR7					
CR8					
CR9	DIODE	910500080	Fairchild	1N753A	5
CR10	Same as CR9				
CR11	Same as CR9				
CR12	Same as CR9				
CR13	Same as CR9				
Q1	TRANSISTOR, PNP	910300065	Fairchild	S2322	4
Q2	TRANSISTOR, NPN	910300046	Fairchild	2N3565	8
Q3	Same as Q2				
Q4	Not Used				
Q5	Same as Q1				
Q6	Same as Q2				
Q7	Same as Q2				
Q8	TRANSISTOR, NPN	910300036	Fairchild	2N3646	2
Q9	Same as Q1				
Q10	Same as Q2				
Q11	Same as Q2				
Q12	Same as Q8				
Q13	Not Used				
Q14	Not Used				
Q15	Same as Q1				
Q16	Same as Q2				
Q17	Same as Q2				
	RECTIFIER, Bridge	910800017	Motorola	MDA942-S	2
R1	RESISTOR, Fixed Composition, 1K ±5%, 1/2W	905000102	Allen Bradley	EB	6
R2	Same as R1				
R3	RESISTOR, Fixed Composition, 2.2K ±5%, 1/4W	906900222	Speer		7
R4	RESISTOR, Fixed Composition, 2.7K ±5%, 1/4W	906900272	Speer		3
R5	RESISTOR, Fixed Composition, 6.8K ±5%, 1/4W	906900682	Speer		3
R6	Same as R3				
R7	RESISTOR, Fixed Composition, 3.9K ±5%, 1/4W	906900392	Speer		3
R8	POTENTIOMETER, 2K	907900228	Beckman	62PA	4
R9	RESISTOR, Fixed Composition, 3.3K ±5%, 1/4W	906900332	Speer		3
R10	Same as R1				
R11	Same as R1				
R12	Same as R3				
R13	Same as R4				
R14	Same as R5				
R15	Same as R3				
R16	Same as R7				
R17	Same as R8				
R18	Same as R9				
R19	Same as R1				
R20	Same as R1				
R21	Same as R3				
R22	Same as R4				
R23	Same as R5				
R24	Same as R3				

Schem Ref. No.	Description	Sierra Stock No.	Mfr.	Dwg. or Mfr. No.	Tot. Quan.
	LOW VOLTAGE POWER SUPPLY A9 (continued)				
R25	Same as R7				
R26	Same as R8				
R27	Same as R9				
R28	RESISTOR, Fixed Composition, 5.6K ±5%, 1/4W	906900562	Speer		1
R29	RESISTOR, Fixed Composition, 680Ω ±5%, 1/4W	906900681	Speer		2
R30	Same as R29				
R31	RESISTOR, Fixed Composition, 820Ω ±5%, 1/4W	906900821	Speer		1
R32	Same as R8				
R33	Same as R3				
R34	Same as R2				
	BOARD, A9		Sierra	F02437600	1
	155V SUPPLY A10				
C1	CAPACITOR, Electrolytic, 30 μF, 250V	902210306	CDE	BR30-250	1
CR1	DIODE, 600 PIV	910500078	G. I.	1N4385	4
CR2	Same as CR1				
CR3	Same as CR1				
CR4	Same as CR1				
CR5	DIODE	910500052		1N825	1
R1	POTENTIOMETER, 100Ω	907900248	Beckman	62PA	1
R2	RESISTOR, Fixed Composition, 220Ω ±5%, 1/2W	905000221	AB	EB	1
R3	RESISTOR, Fixed Composition, 150K ±5%, 1/4W	906900154	Speer		1
R4	RESISTOR, Fixed Composition, 100K ±5%, 1/2W	905000104	AB	EB	1
	BOARD, A10	C02437700			1
	ANALOG POWER OUTPUT BOARD	B02688500			
A1	MICRO LOGIC – 709C	920300008			1
C1	CAPACITOR, Ceramic, 2.2 μF, 25V	901400225			4
C2	Same as C1				
C3	Same as C1				
C4	Same as C1				
C5	CAPACITOR, Durmica, 220 pF ±10%, 500VDCW	901900050	El Menco	DM15-050K	1
C6	CAPACITOR, Durmica, 4700 pF ±5%, 500VDCW	901900472	Speer		1
C7	CAPACITOR, Vertilytic 1 μF 25 VDCW	903300105			
R1	RESISTOR, Fixed Composition, 10K ±5%, 1/4W	906900103	Speer		4
R2	Same as R1				
R3	Same as R1				
R4	Same as R1				
R5	RESISTOR, Fixed Composition, 150Ω ±5%, 1/4W	906900124	Speer		1
R6	POTENTIOMETER, 5K	907900225			1
R7	RESISTOR, Fixed Composition, 1K, ±5%, 1/4W	906900102	Speer		1
R8	RESISTOR, Fixed Composition, 1.5K ±5%, 1/4W	906900152	Speer		1
	P. C. BOARD		Sierra	B02688400	1
	MAIN CHASSIS, FRONT AND REAR PANEL				
B1	FAN, 115V, 12W, 35 CFM	917200018	Sprite	SP2A2	1
	GUARD	917300370	Sprite		1
	CORD	916400024	Sprite		1

Schem Ref. No.	Description	Sierra Stock No.	Mfr.	Dwg. or Mfr. No.	Tot. Quan.
	MAIN CHASSIS, FRONT AND REAR PANEL (continued)				
C1	CAPACITOR, Electrolytic, 10,000 μF, 10V	902200109	Mallory	FPO 42.8	1
C2	CAPACITOR, Electrolytic, 150 μF, 300V	902200157	Sprague	TVL-1584	1
C3	CAPACITOR .01μF, 150V	901440103	Centralab	DDM-103	3
C4	Same as C3				
C5	Same as C3				
CR1	DIODE	910500051	G. E.	1N3569	8
CR2	Same as CR1				
CR3	Same as CR1				
CR4	Same as CR1				
CR5	Same as CR1				
CR6	Same as CR1				
CR7	Same as CR1				
CR8	Same as CR1				
F1	FUSE, 1A SB 115V (1/2A SB 230B)	913200007	Bussman	MDL-1	1
	FUSEHOLDER	913400001	Littelfuse	342003	1
FL1	FILTER, Low-Pass, 25 Hz	910100039	S. A. E.	946	1
FL2	FILTER Assembly		Sierra	C02436300	1
FL3	Not Used				
FL4	Not Used				
FL5	FILTER, Low-Pass, 15 Hz	910100044	S. A. E.	947	2
FL6	Same as FL5				
J1	CONNECTOR, Assembly				
	Binding Post, Black Top	915200012	General Radio	938-C	8
	Binding Post, Metal Top	915200013	General Radio	938-A	4
	Binding Post, Insulator Pair	915200014	General Radio	938-BB	6
	Binding Post, Shorting Link	915200007	General Radio	938-L	4
J2	CONNECTOR, BNC Type	914600074		UG-657/U	4
J3	Same as J1				
J4	Same as J1				
J5	Same as J1				
J6	RECEPTACLE, Power	914800077	Switchcraft	AC3G	1
J7	Same as J2				
J8	CONNECTOR, 10 Pin	914800073	Viking Ind.	VK10S/1-2	9
J9	CONNECTOR, 22 Pin	914800075	Viking Ind.	VK22S/1-2	13
J10	Same as J8				
J11	Same as J9				
J12	Same as J8				
J13	Same as J9				
J14	Same as J8				
J15	Same as J9				
J16	Same as J8				
J17	Same as J9				
J18	Same as J8				
J19	Same as J9				
J20	Same as J8				
J21	Same as J9				
J22	SOCKET, Octal	914000021	Cinch-Jones	9977	1
J23	Same as J9				
J24	Same as J9				
J25	Same as J8				
J26	Not Used				
J27	Same as J8				
J28	Not Used				

Schem Ref. No.	Description	Sierra Stock No.	Mfr.	Dwg. or Mfr. No.	Tot. Quan.
	MAIN CHASSIS, FRONT AND REAR PANEL (continued)				
J29	Not Used				
J30	Not Used				
J31	Same as J9				
J32	Not Used				
J33	Not Used				
J34	Same as J9				
J35	Same as J9				
J36	Same as J9				
M1	METER, 0-50 μA	911800106	Weston	Model 111	2
M2	Same as M1				
OSC1	OSCILLATOR, 1 MHz, Sierra Spec. A02375100 or OSCILLATOR, 1 MHz (with Varicap) Sierra Spec. A02375100 Rev. C	912400001	Ovenaire		1
Q1	TRANSISTOR, NPN, Power	910300057	RCA	40250	4
Q2	TRANSISTOR, NPN, Power	910300058	RCA	40251	4
Q3	Same as Q1				
Q4	Same as Q2				
Q5	Same as Q1				
Q6	Same as Q2				
Q7	Same as Q1				
Q8	Same as Q2				
Q9	TRANSISTOR, PNP	910300062	Motorola	2N3741	1
R1	RESISTOR, W.W. 34.36Ω ±0.1%, 1/4W	906100115	Rich Ind.	7010	1
R2	RESISTOR, W.W. 387.9Ω ±0.1%, 1/4W	906100117	Rich Ind.	7010	1
R3	RESISTOR, W.W. 640.3Ω ±0.1%, 1/4W	906100119	Rich Ind.	7010	1
R4	RESISTOR, W.W. 80.00Ω ±0.1%, 1/4W	906100114	Rich Ind.	7010	1
R5	RESISTOR, W.W. 109.9Ω ±0.1%, 1/4W	906100116	Rich Ind.	7010	1
R6	RESISTOR, W.W. 257.6Ω ±0.1%, 1/4W	906100118	Rich Ind.	7010	1
R7	RESISTOR, W.W. 331.5Ω ±0.1%, 1/4W	906100120	Rich Ind.	7010	1
R8	RESISTOR, W.W. 820.5Ω ±0.1%, 1/4W	906100089	Rich Ind.	7010	1
R9	RESISTOR, W.W. 259.5Ω ±0.1%, 1/4W	906100090	Rich Ind.	7010	1
R10	RESISTOR, W.W. 82.05Ω ± 0.1%, 1/4W	906100092	Rich Ind.	7010	1
R11	RESISTOR, M.F. 26.10Ω ±1%, 1/4W	908300072	Electra	MF5C	1
R12	RESISTOR, W.W. 8.215Ω ±0.1%, 1/4W	906100094	Rich Ind.	7010	1
R13	RESISTOR, W.W. 2.598Ω ±0.1%, 1/4W	906100095	Rich Ind.	7010	1
R14	RESISTOR, W.W. 1.201Ω ±0.1%, 1/4W	906100096	Rich Ind.	7010	1
R15	Not Used				
R16	Not Used				
R17	POTENTIOMETER, 500Ω	907900249	Beckman	Model 7216 R500L.25	1
R18	Not Used				
R19	POTENTIOMETER, 500Ω Linear, 2W	907900065	AB	Type J	1
R20	RESISTOR, Fixed Composition, 2.2K ±5%, 1/2W	905000222	AB	EB	1
R21	RESISTOR, Fixed Composition, 2.2K ±5%, 1/4W	906900222	Speer		1
R22	RESISTOR, W.W. 2.05K ±1%, 1/4W	906100077	Rich Ind.	7010	1
R23	RESISTOR, W.W. 649Ω ±1%, 1/4W	906100076	Rich Ind.	7010	1
R24	RESISTOR, W.W. 301Ω ±1%, 1/4W	906100075	Rich Ind.	7010	1
R25	POTENTIOMETER, 500Ω (P/O S5)	907900239	AB	JA4N0485501UA	1
R26	RESISTOR, Fixed Composition, 1K ±5%, 1/2W	905000102	AB	EB	1
R27	RESISTOR, Fixed Composition, 8.2K ±5%, 1/4W	906900822	Speer		12
R28	Same as R27				
R29	Same as R27				

Schem Ref. No.	Description	Sierra Stock No.	Mfr.	Dwg. or Mfr. No.	Tot. Quan.
	MAIN CHASSIS, FRONT AND REAR PANEL (continued)				
R30	Same as R27				
R31	Same as R27				
R32	Same as R27				
R33	Same as R27				
R34	Same as R27				
R35	Same as R27				
R36	Same as R27				
R37	Same as R27				
R38	Same as R27				
R39	POTENTIOMETER, 5K/500Ω Dual	907900252	Beckman	Model 7216 R5K L.25 R500 L.25	1
R40	RESISTOR, W.W. 2.14KΩ ±1%	906100106	Rich Ind.	P-1	1
R41	Dual with R39				
R42	RESISTOR, W.W. 259.5Ω ±0.1%, 1/4W	906100090	Rich Ind.	7010	1
R43	RESISTOR, W.W. 820.5Ω ±0.1%, 1/4W	906100089	Rich Ind.	7010	1
R44	RESISTOR, W.W. 120Ω ±0.1%, 1/4W	906100091	Rich Ind.	7010	1
R45	RESISTOR, W.W. 409.8Ω ±0.1%, 1/4W	906100121	Rich Ind.	7010	1
R46	RESISTOR, W.W. 2195Ω ±0.1%, 1/4W	906100122	Rich Ind.	7010	1
R47	RESISTOR, W.W. 2958Ω ±0.1%, 1/4W	906100123	Rich Ind.	7010	1
R48	RESISTOR, W.W. 75Ω ±1.0%, 1/4W	906100079	Rich Ind.	7010	1
R49	RESISTOR, W.W. 135Ω ±1.0%, 1/4W	906100080	Rich Ind.	7010	1
R50	RESISTOR, W.W. 600Ω ±1.0%, 1/4W	906100081	Rich Ind.	7010	1
R51	RESISTOR, W.W. 900Ω ±1.0%, 1/4W	906100107	Rich Ind.	7010	1
R52	Not Used				
R53	Not Used				
R54	Not Used				
R55	Not Used				
R56	Not Used				
R57	RESISTOR, Fixed Composition, 10K ±5%, 1/2W	905000103	Speer		1
R58	POTENTIOMETER, 500 ohm	907900274	Helipot	Type 7246	1
R59	RESISTOR, Fixed Composition, 1K ±5%, 1/4W	906900102	Speer		2
R60	Same as R59				
R61	RESISTOR, 100K ±5%, 1/2W	905000104	AB	EB	1
S1	SWITCH, Rotary, Sierra Spec. A02655000	911200156	Oak	Type F	1
S2	SWITCH, Rotary, Sierra Spec. A02397100	911200126	Oak	Type F	1
S3	SWITCH, Rotary, Sierra Spec. A02376500	911200138	Oak	Type F	2
S4	SWITCH, Rotary, Sierra Spec. A02400300	911200125	Oak	Type F	1
S5	SWITCH, Rotary, Sierra Spec. A02397300	911200137	Oak	Type F	1
S6	SWITCH, Rotary, Sierra Spec. A02361300	911200153	Oak	Type F	1
S7	Not Used				
S8	SWITCH, Rotary, Sierra Spec. A0239700	911200136	Oak	Type F	1
S9	SWITCH, Rotary, Sierra Spec. A02399400	911200128	Oak	Type F	1
S10	SWITCH, Rotary, Sierra Spec. A02654600	911200155	Oak	Type F	1
S11	SWITCH, SPDT	911400021	Stackpole	SS-26-1	1
S12	SWITCH, Rotary, Sierra Spec. A02652500	911200154	Oak	Type F	1
S13	SWITCH, Slide, DPDT	911000040	Switchcraft	46256LF	1
T1	TRANSFORMER, Power	910000096	Edcor Eng.	S63007	1
T2	TRANSFORMER, Isolation, Sierra Spec. A02634700	910200011		080-20999-000	2
T3	Same as T2				
	POWER CORD, 8 ft.	916400019	Belden	17258	1